

TRANSLATION

RAPID-ACTION ELECTRONIC COMPUTER
OF USSR ACADEMY OF SCIENCES

By A. A. Pavlikov

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RAPID-ACTION ELECTRONIC COMPUTER OF THE USSR ACADEMY OF SCIENCES
MAGNETIC MEMORY DEVICE

by
Z. A. Pavlikov

P r e f a c e

This issue from the Series "BESM" was written on the basis of the materials used in designing the magnetic memory device (MMD)* for the rapid-action electronic computing machine of the USSR Academy of Sciences, and was also based on data from its operation.

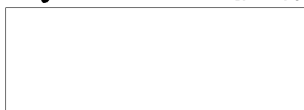
The whole process of the construction of the MMD can be divided into three stages: 1st, 1951, projection and erection of the mockup for experimental purposes; 2nd, April to December, 1952, projection and building of the MMD and putting it into operation; 3rd, improving the MMD in the process of experimental operation.

In the first stage, the work was carried out in the group of engineer K. S. Neslukhovskiy, by the engineers A. S. Fedorov and L. A. Orlov. In the second stage, engineers, K. S. Neslukhovskiy, L. A. Orlov, V. F. Petrov, M. V. Tyapkin, A. S. Fedorov and the author took part in the work.

All the work in the construction of the MMD was carried out in accordance with the data and under the direct supervision of the chief designer of the BESM, Academician S. A. Lebedev.

The improvement of the MMD in the process of operation during the course of 1954 was done by the author together with Engineer M. V.

*For meaning of this and most subsequent abbreviations, see "Abbreviated Symbols" list at beginning of translation (Translation Editor).



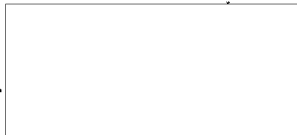
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Tyapkin. As a result of circuit simplification, the number of electron tubes was reduced from 1,900 to 700, with a simultaneous increase in the dependability of the circuit's operation.

In this issue, a description is given of the MMD which has been in regular operation since 1954.

The circuits, as well as the standard electron units of the MMD, are presented in the supplements, and explanation of the abbreviated symbols used in the text is given.*

*Translation Editor's Note: Supplement of symbols was transferred to front of translation, was expanded, and English conventions were added.



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ABBREVIATED SYMBOLS

<u>As In Original</u>	<u>As In Translation</u>	<u>Meaning</u>
AI	A1	first address of command code
A2	A2	second address of command code
A3	A3	third address of command code
A1B3K	A1MCU	first address of Memory Command Unit
A2B3K	A2MCU	second address of Memory Command Unit
A3B3K	A3MCU	third address of Memory Command Unit
A3MYK	A3LCC	receipt of code, in the cells of the unit of Local Control of the Commands, from the cells of the A3MCU
A3MYK	RCCCC	receipt of the code, in the cells of the Central Control of Commands unit, from the A3MCU cells
B3K	MUC	memory unit of commands
B3CM	BESM	high-speed electronic computer
B	V	valve, standard unit of the BESM
BBKB	CIOU	Codes' Input and Output Unit on the magnetic memory device's drum
BBKI	CIOU-t	Codes' Input and Output Unit on magnetic memory device's tape
B3a	VAD	Valve and Amplifier with Delay, standard unit of the BESM
B3V	IMD	Internal Memory Device
B4	EN	emission of number
B4M3V	ENMD	Emission of Number from the Magnetic Memory Device

*Original Russian abbreviations have been converted to English lettering 1) to match the full English meanings and 2) to facilitate final copying of translation. (Translation Editor).

ГМК	GCP	Generator of Control Pulses
ГОН	GSP	Generator of Single Pulses
Дд	Dp	Diode Potential unit, standard BESM unit
ДЗУ	DMD	Diode Master Device
Зв	Ав	Amplifier with Exchangeable delay; standard BESM unit
ЗПБЗУ	RoIMD	"Remembering" operating in the IMD
ЗП"1"	Rc"1"	"Remembering" code "1"
ЗП"0"	Rc"0"	"Remembering" code "0"
ИЗОП	PCO	Pulse of Completion of Operation
И7	I7	7th pulse
И40	I40	40th pulse
И	I	potential Inverter, standard BESM unit
ИРСИ	PCS	Pulse of Coincidence Solution
ИСИ	PC	Pulse of Coincidence
ИСи	Pr	Pulse of Reading
Ка	Ca	Cathode repeater on 6П3 tube, standard BESM unit
КБ	Cb	Cathode repeater on 6ПЕ tube, standard BESM unit
КМ1, КМ2	CM1, CM2	Commutator 1, 2
КМГ	CMG	Commutator of groups on Magnetic Drum
КМЛ	CMT	Commutator of Magnetic Tape
КМД	CMDT	Commutator of Magnetic Drum Track
КОП	COP	Commutator of Operation
КБ	CB	Code Bars
КБА	CBA	Code Bars of Address

I	Ta	Tape
II...I4	T1...T4	Tapes of Magnetic Memory Device
M	M	Multivibrator
MB	MD	Magnetic Drum
MI	MT	Magnetic Tape
M3Y	MMD	Magnetic Memory Device
M3a	CR	Command for Recourse to the MMD
M3c	CPS	Command Permitting Start of Codes' Exchange
M3YB	MMDD	Magnetic Memory Device using Drum
M3YI	MMDT	Magnetic Memory Device using Tape
MYK	LCC	Local Control of Commands
MYOp	LCOp	Local Control of Operations
IIAK	TCA	Transmission of Command's Address
IIAI	TC-1	Transmission of Address Code from cells of A1MCU to the CBA
IIA2	TC-2	Transmission of Address Code from cells of A2MCU to the CBA
IIA3	TC-3	Transmission of Address Code from cells of A3MCU to the CBA
IIAKM	TC-LCC	Transmission of Command's Address from cells of LCC unit to the CBA
IIAKH	TC-CCC	Transmission of Command's Address from cells of CCC unit to the CBA
IKK	RC	Receipt of Command
IV	CB	Control Board
IVM3Y	CB-MMD	Control Board of MMD
PAIM	RAIM	1st Register of Address of MMD

PA2M	RA2M	2nd Register of Address of MMD
P3Y	MDM	Memory Device on Electro-acoustic mercury tubes
PCn	SC	Solution of Coincidence
PCnI	SCMT	Solution of Coincidence on Magnetic Tapes
PCnE	SCMD	Solution of Coincidence on Magnetic Drum
PCnM3Y	SC MMD	Solution of Coincidence on MMD
PCnB3Y	SC IMD	Solution of Coincidence on IMD
CxCn	CC	Circuit of Coincidence
CxB3Y	OR IMD	Operation of Reading from IMD
CxD3Y	OR DMD	Operation of Reading from DMD
Cn	Pc	Potential of "coincidence"
CnMB	SPMD	Synchronizing Pulses from Magnetic Drum
Cn	SP	Synchronizing Pulses
CnE	SP-D	Synchronizing Pulses of Drum
CxCn	CSP	Counter Synchronizing Pulses
CxCnD	CTNC	Counter of Track Number Coincidence
CxCnK	CCNC	Counter of Code Number Coincidence
Cx40	C40	Counter 40 of MMD or MMDT
T	T	Trigger, standard BESM unit
TE	TD	Trigger of Drum
T3n	RT	Recording Trigger
T3nCn	RRT	Recording and Reading Trigger
TR3	RPT	Recording Pulse Trigger
TK3Y	TCMD	Trigger Control Memory Device

P
↓
T

TI	TT	Tape Trigger
TRep	TRew	Rewinding Trigger
TRp	DT	Drive Trigger
TRCp	CST	Coincidence Solution Trigger
TRCpB	CST-D	Coincidence Solution Trigger (Drum)
TRCpL	CST-Ta	Coincidence Solution Trigger (Tape)
TCp	CT	Coincidence Trigger
TVp	CoT	Control Trigger
TVpL	CoTT	Control Trigger of Tape
TVASM	TS2A	Trigger for Setting 2nd Address
Tv	NT	Number Trigger
YK	CoC	Control of Commands
YMSV	CMMD	Control of MMD
YMSVB	CMMD	Control of MMD on Drum
YMSVL	CMMDT	Control of MMD on Tape
YOp	CoO	Control of Operations
Y3p	RA	Recording Amplifier
Y3pB	AR-MD	Amplifier of Pulses to be Recorded on Magnetic Drum
Y3pL	AR-MT	Amplifier of Pulses to be Recorded on Magnetic Tape
Y3p"1"	AP"1"	Amplifier of "1" Pulses
Y3p"0"	AP"0"	Amplifier of "0" Pulses
YCbB	AP-MD	Amplifier of Pulses, Read from Magnetic Drum
YCVL	AP-MT	Amplifier of Pulses, Read from Magnetic Tape
Y"0"	S"0"	Setting of cell in "0" position

Y"I"	S"1"	Setting of cell in "1" position
Y"0"B3CM	S"0"BESM	Setting of all BESM Elements in "0" position
Y"0"D3Y	S"0"DMD	Setting of cells of DMD in "0" position
Y"0"M3Y	S"0"MMD	Setting of cells of MMD in "0" position
Y"0"TYA2M	S"0"CTA2M	"0" Setting of Control Trigger of Receipt of Address in 2nd Registers of MMD Address
Y"0"IV	S"0"CC	Setting of Central Control Cells in "0" position
Y"I"LYK	S"1"LCC	Setting of Code "1" in Cells of LCC unit
Y"I"TY2M	S"1"CT2M	"1" Setting of Control Trigger of Receipt of Address in 2nd Registers of MMD Address
Y"I"IVK	S"1"CCC	Setting of Code "1" in Cells of Central Control of Commands
Φ	S	Shaper, standard BESM unit
IV	CC	Central Control
IVK	CCC	Central Control of Commands
IVOn	CCOp	Central Control of Operations
T"I"YK	T"1"LCCC	Addition of a Unit to Code in Cells of LCC unit
T"I"YK	T"1"CC	Addition of a Unit to the Code in Cells of CCC or LCC unit
C4I	C-SP1	Counter of SP of one Number
C42	C-MD2	Counter of number within limits of one track of magnetic drum
C43	C-MD3	Counter of magnetic drum tracks; it computes codes for the magnetic tape (continuation of the C-MD2)

CHAPTER I

General Part

1. PURPOSE AND BASIC PARAMETERS OF THE MAGNETIC MEMORY DEVICE

The magnetic memory device (MMD) is an external memory device of the high speed electronic computing machine of the USSR Academy of Sciences (BESM). It is intended to expand the capacity of the internal memory device (IMD), and also to make deductions from the computational results.

In the BESM, two types of the MMD are used: (a) a continuously revolving drum covered by a thin layer of ferromagnetic material (MDD), (b) four magnetic-tape recorders of the B-2-52A type, equipped with a magnetic tape that is connected whenever it is needed (MDT).

The drum is designed for a memory of 5,120 codes (5 groups of 1,024 codes, each group having a capacity equal to that of the IMD, and each of the magnetic tapes for a memory of 25 to 30,000 codes.

The capacity of the MDD is determined by the dimensions of the drum surface and the permissible compactness of the recording, i.e., the capacity of the magnetic drum is limited. The capacity of the MDT depends only on the length of the tape and can easily be increased.

The rather large capacity of the magnetic drum and the magnetic tape, used as a memory device, creates greater convenience in programming and greatly expands the range of problems solvable on the BESM.

Direct exchange of codes between drums and magnetic tapes was not provided for. All the operations of transferring codes from drums to

magnetic tapes are done only through the MMD.

The recording of the codes on the drum and on the magnetic tapes is accomplished in the process of the BESM's operation. These may be the results of computations, definite programs, or even data from the input unit. The recording (or computation) of the codes on the drum is done for expediency with whole groups at once. This reduces the time loss in waiting for codes. When the drum turns at 750 rpm, the average time for getting to the proper place on the magnetic coating under the magnetic head amounts to 40 millisec. The consequent selection (or recording) takes place with a speed of 800 numbers per second.

In contrast to other devices of the BESM, the memory devices on the magnetic drum and tapes are designed on the consecutive principle, i.e., the recording and computation of the codes is done consecutively, step by step.*

The conversion of the codes (parallel into consecutive in recording on the MMD and consecutive into parallel in computation) takes place in the receiving register of the arithmetical device of the BESM.

For convenience in preventive checking of the magnetic memory device, the control panel of the MMD is used.

In the greater part of the circuit of the electronic automatic

*On the 6.5 millimeter standard magnetic tapes used in the BESM, parallel recording is in general impossible. Some increase in the rapid action during the operation of the exchange of codes between the MMDD and the MMD can be obtained, but only at the expense of considerable increase in size of the equipment and a lowering of the dependability of the work. Therefore the use of the parallel principle for the MMDD does not prove feasible.

equipment, standard units are employed, used in the BESM and described by V. A. Zimin in his book, "High Speed Electronic Computing Machine. Standard Units", (Publishing Office of the USSR Academy of Sciences, 1952)*.

A lead-in device on perforated tape is directly connected with the MMD unit, which uses the automatic equipment of the MMDT and is intended for the feeding of programs into the internal memory device.

Thus, the MMD consists of:

Magnetic drum, designed constructively in the form of a separate unit;

Four apparatuses for recording on magnetic tape (B-2-52A magnetic-tape recorders);

Input unit and output of codes onto the magnetic tapes;

Control unit of the MMD;

Input device on perforated tape;

Control panel of the MMD.

2. THE LAYOUT OF THE MAGNETIC MEMORY DEVICE (MMD)

The following basic units (Fig. 1) are in the assembly of the MMD:

Drum MD, covered with a thin coating of magnetic material (ferromagnetic lacquer) for storing the codes recorded on it and processing the solution of a problem on the BESM**;

*The principles of the circuits of the standard units and specifications of the equipment are given in supplement No. 1.

Magnetic heads, each of which corresponds to a track on the surface of the drum are located over the continuously revolving drum;

The input unit and the output of the codes onto the drum (CIOU) for the recording and reading of the codes from the given tracks of the drum;

The device on magnetic tapes MT for storing the codes recorded on them at the time of the operation of the BESM, and for extracting from it the final results of the problem solved; this device is designed in the form of separate magnetic-tape recorders, in each of which there is an attachment (for transporting the tapes) and magnetic heads: recording, reproducing and erasing;

The input device on perforated tape PT for primary introduction of the programs into the IMD of the BESM; this device comprises a separate unit consisting of a tape-transporting mechanism and a photoelectric transmitter;

An input and output device onto the magnetic tapes, and also an output of the codes from the perforated tape (CIOU-t) for recording and reading the codes from a given magnetic tape or reading the codes from the perforated tape;

Commutation unit (BK) for selecting a given path of the magnetic drum of a given magnetic-tape recorder when converting to the magnetic tape;

**The magnetic coating of the drum is similar in its properties to the coating of the magnetic tape, type C, used for sound recording.

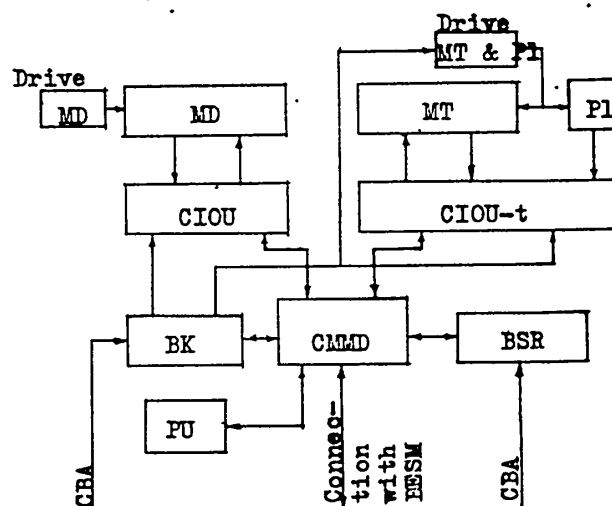


Fig. 1. Layout of the Magnetic Memory Device (MMD)

Unit of counters and address register (BSR); the computers serve for computation of the synchronizing pulses and the number of introduced and extracted codes when converting to MMD, and the register for interval storing of the address codes on the drum or tape when converting to MMD;

The control unit of the magnetic memory device (CMMD) is connected directly with the control of the EESM, and controls the exchange of codes between the IMD and MMD;

The control board (CB) makes the adjustment of the MMD easier, and makes it possible to effect preventative checks of its work when disconnected from the EESM.

Besides the units of the MMD enumerator, for conversion of the codes from the parallel to series in recording and from series to parallel in reading, there is used (as a displaceable register) a

memory unit of the second number (BZ2Ch)* of the arithmetical device BESM.

3. MAGNETIC RECORDING

One of the basic advantages of the memory device with magnetic recording is that of the great capacity with a comparatively little amount of equipment and unlimited time of storing the codes without periodical renewal (recording) of the signals. The recorded codes are preserved even under conditions of connecting in a calculating machine, and external action is required to erase the recorded data.

In the process of magnetic recording, the magnetic material is moving in relation to the gap of the magnetic head. The latter is a specially designed electromagnet, through the winding of which flows the current of the signal being recorded. Each of the elementary particles of the magnetic material passing under the play of the recording head is magnetized in accordance with the magnitude of the current of the signal which flows in a given moment through the winding of the head. This magnetic condition is preserved even after the elementary particles go past the head. The means for remembering in this case proves to be the change in the intensity of the residual magnetism in the small volume of the magnetic material.

In reading (playback), the magnetic material is displaced with relation to the reproducing head which is similar in design to the

*Here, et passim. in translation, certain abbreviations are given in original lettering, for lack of English meaning (Translation Editor).

recording one. A part of the magnetic flux from that particle of magnetic material which finds itself in immediate proximity to the gap circulates through the core of the head. The change in time of the flux produces an emf in the head windings.

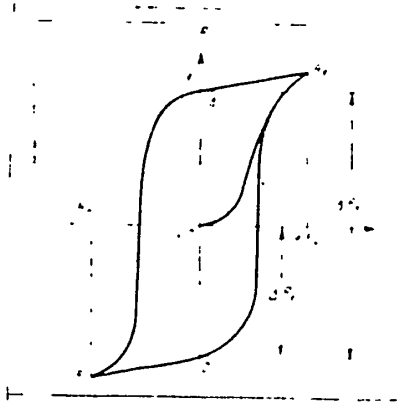


Fig. 2. Hysteresis Loop of the Magnetic Material

In recording and reading a binary code, it is not required that the output voltage repeat precisely the form of the recording signal. It is quite sufficient that the system dependably distinguish two possible conditions of magnetic material.

In Fig. 2, a hysteresis loop of the magnetic material is presented. Point O corresponds to the unmagnetized condition of the material, and points A and B, to the positive and negative signs of the residual magnetic induction.

Before the operation, the material is magnetized positively to the condition of saturation, i.e., by the curve OA_1A , point O is transferred to point A. It is sufficient to create a negative magnetic field near the proper sector of the coating in order for the magnetic condition of this sector to be transferred by the curve AB_1B to point B. We conventionally assume the positively magnetized state of the material to be zero, and the negatively magnetized as the unit "1"; then every elementary particle of the magnetic coating

will become a memory cell with two stable states, "0" and "1". It is easy to see that in order to get the state "1" it is sufficient to create a negative magnetic field, H_0 , and to get the state "0", a field $+H_0$ is needed. Independently of the previous condition of a given particle, it will be changed over correspondingly to the state "1" or "0".

The memory of data on the magnetic coating consists basically of three processes: erasing, recording and reading recorded material.

The erasing is done for destroying the previously recorded data and putting the magnetic material into the initial state necessary for new recording.

The erasing may consist either of complete demagnetization, or complete magnetization to the point of saturation of the magnetic material. During such erasing, the saturation of the magnetic material is attained by means of direct current. For this, the moving magnetic coating (medium) is put into a sufficiently intense magnetic field. The erasing head which creates this field consists of an electromagnet fed by direct current.

The demagnetizing of the magnetic material can be accomplished by erasing with an alternating current. On each of the elementary particles of the magnetic material, an alternating magnetic field arises, whose intensity is reduced to zero after a large number of changes. In order for the demagnetization of a given part to be accomplished rapidly, the erasing magnetic field should alternate with high frequency, but in doing this it may turn out that the penetration of the

erasing field into the magnetic material is insufficient for complete eradication of the previous signals.

The use of high frequency demagnetization in sound recording insures the expansion of the dynamic range to 55 or 60 db.

For memory devices of calculating machines, such a wide dynamic range is not required. Therefore in this case one can erase with direct current.

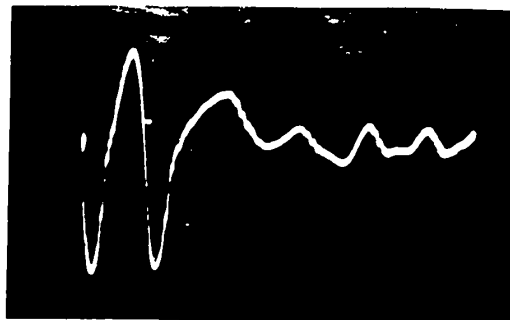


Fig. 3. Oscillogram of the Reproduction of Impulses

Left part of the curve, recording;
right part, remainder after erasing

In erasing recordings of pulses which possess high frequency of sequence by means of demagnetization of the carrier with the use of an alternating magnetic field, it is necessary to use a frequency considerably higher than the frequency of the sequence of the pulses. However, the obtaining of a magnetic field of the required magnitude is quite difficult.

With the method of recording usually used in the MMD at two levels on the tapes (MMDT), erasing is done with the use of a constant magnetic field produced in the gap by a special erasing head.

In the memory device on the magnetic drum, it is often required to erase only one of a series of pulses, and this brought about the pulse method of erasing (recording of code "0") with the application of a constant field by means of an antiphase superimposition of the erasing pulse on the recording.

As a zero level (code "0") one uses constant saturation of the material. Recording of the pulse of code "1" is done by means of a local remagnetization of an elementary particle of the magnetic coating, for which a field is created in the opposite direction to that of the original magnetization.

Erasing (recording code "0" in place of code "1") is done by pulses which reduce the magnetic coating to the original state of saturation.

If one pulse is erased with the aid of another and both are of equal length and amplitude, complete erasing does not take place. Fig. 3 shows an oscillogram of the reproduction of a recorded pulse and the residual part after erasing.

The magnetic field over the slot of the recording head has the maximum intensity within the slot; on the edges, its intensity falls off smoothly (during contactless recording on the drum).

If the intensity within the slot is equal to the intensity of saturation, intensities will be considerably less at the edges. Therefore when erasing a pulse by use of another pulse, the middle part of the magnetized particle of the magnetic coating will be brought by the erasing pulse to saturation, whereas the edges of the erased particle are almost unchanged. As a result, there remains on the coating the unerased part of the recording in the form of two pulses located in isolation one from the other at a distance equal approximately to the length of the recorded pulses. Inasmuch as the residual pulses in erasing are obtained as a result of the low intensity of the

field on the edges of a given particle of the recording, it is expedient to produce pulses of greater length than in recording. In this connection, it is necessary that the leading edge of the erasing pulse be delayed with relation to the trailing edge of the recorded one.

The volume of recording devices equipped with a magnetic coating depends on the geometrical dimensions of the coating and the permissible density of the recording per unit of its surface.* Density of the

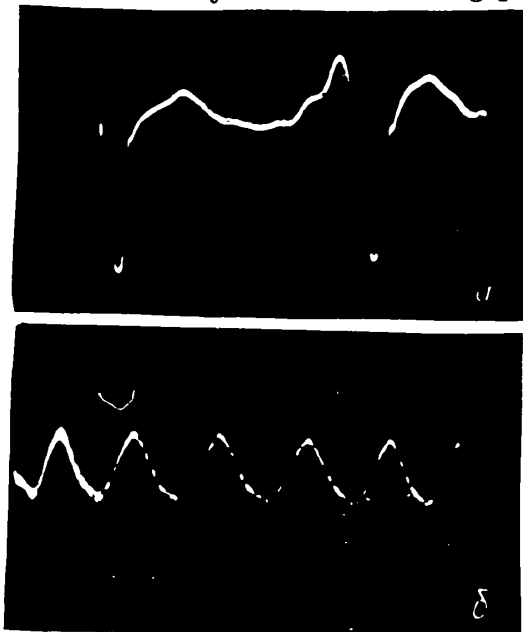


Fig. 4. Oscillograms of Reproduced Impulses, Recorded at Different Frequencies.

a- at $f = 6$ kcps;
b- at $f = 33$ kcps.

recording in turn depends on the parameters of the magnetic recording channel (parameters of the head, characteristics of the coating, gap between the head and the magnetic coating). The working frequency of the magnetic memory device is determined by two factors: the density of the recording and the speed of the carrier motion.

As experience shows, the use of contact recording at great speeds leads to considerable heating and abrasure of working surfaces, heads, and magnetic coating. Therefore when working with a rate of movement of the coating at 4 to 5 m/sec and higher, it is necessary to

*By density of the recording, one understands the maximum possible number of pulses recorded on a unit of length of the magnetic coating.

set the gap. Its magnitude should be as small as possible since an increase in gap sharply lessens the signal output during computation and decreases the permissible density of the recording as well.

As a rule, the gap size is limited by the possibilities of the mechanical system (vibration in the bearings, and temperature changes). In the magnetic drum of the BESM built in 1952 by the All-Union Institute of Sound Recording, the vibration in the bearings amounted to 5 - 8 microns. Besides, the materials of which the device was made were selected without taking temperature compensation into account. For these reasons the size of the air gap between the heads and the magnetic covering was set at 40 - 50 microns.

In Fig. 4, oscillograms are shown of reproduced pulses after the amplifier, which were recorded at different frequencies.*

Let us clarify what it is that limits the maximum number of pulses for a unit of length of the magnetic covering. With an increase in the number of pulses recorded per unit of length of the coating, the superimposition of pulse on pulse takes place. With the overlapping of pulses, some particles of the magnetic coating will be subjected (in time) to the action of two magnetizing fields. The magnetic condition of the coating will be determined by a large field.

As a result of the limiting width of the head slot, the recorded pulses on reproduction will be neutralized, and the magnetic flow in the head will resemble that shown in Fig. 5, from which one can see

*Ambiguity of this sentence also occurs in original (Editor).

that the steepness of the characteristic curve is lessened. This leads to a decrease in the amplitude of the reproduced signals.

It has been confirmed experimentally that the superimposition of the time characteristic is permissible at a level not greater than 0.2 of the maximum magnitude.

The impulse on the magnetic coating is differentiated in reproduction and has the form shown in Fig. 6.

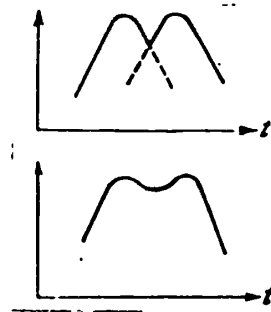


Fig. 5. Form of the Resulting Voltage of a Reproduced Pulse in the Case of Recording with Overlapping.

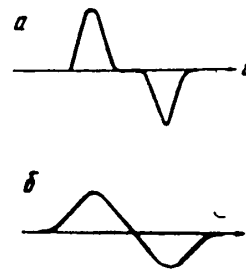


Fig. 6. Form of the Signal Read from the Magnetic Head of the Drum.

a, with less density of recording; b, with high density.

Ordinarily, in reproduction, one-half of the pulse is cut off and at the output of the amplifying device, one gets a pulse in unipolar form.

On the basis of what is stated above, the density selected for recording on the magnetic drum was selected at about 3 pulses for 1 mm.

The required length of the pulse of recording depends on the speed of motion of the magnetic coating, the width of the slot of

the recording head, the characteristics of the material of the magnetic coating, the gap between the head and the magnetic covering, etc.

The determination of the length of the recording pulse by the computation method proved to be difficult. For the recording device described, the length of the recording pulse of the drum was selected experimentally. The optimum pulse proved to be equal to 7.5 microsec.

With a length of recording pulse of 5 microseconds or less, the amplitude of the signals read was already noticeably reduced; with a length greater than 10 microseconds, the amplitude of the signals read also begins to decrease on account of the overlapping of the recorded pulses.

CHAPTER II

M a g n e t i c - D r u m M e m o r y D e v i c e (MMDD)

1. MAGNETIC DRUM (MD)

The basic element of the MMDD is the drum (Fig. 7) with a diameter of 300 mm and a length of 270 mm, covered with a thin coating of ferromagnetic material. Along the generatrix of the drum, there is placed a row of recording and reproducing magnetic heads spaced 40 to 60 microns from the magnetic coating. The heads with closed magnetic circuits each have two windings running counter to each other (Fig. 8). Depending on which winding a pulse of electric current falls into, the particle of the magnetic coating near the operative gap of the head will be magnetized positively or negatively, i.e., it is put into the position "0" or "1".

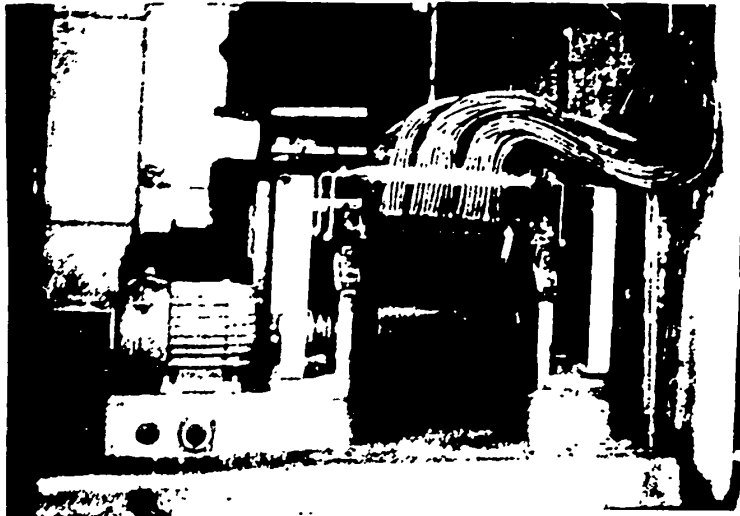


Fig. 7. Magnetic Drum

The same heads serve for reading from the magnetic drum. When

a magnetized particle of the coating passes under the head, an emf is produced.

$$E = k \frac{d\phi}{dt}$$

where ϕ is the magnetic flux created in the magnetic circuit of the head by the magnetic layer of the drum and k is the coefficient of proportionality.

At the moment when an elementary particle passes under the head, with the latter in the state "1", there is induced in the windings of the head a potential (Fig. 9), its amplitude being several tens of a millivolt.

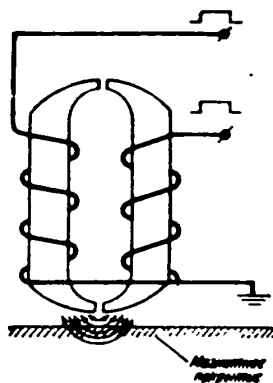


Fig. 8. Circuit of the Recording and Reproducing Magnetic Head

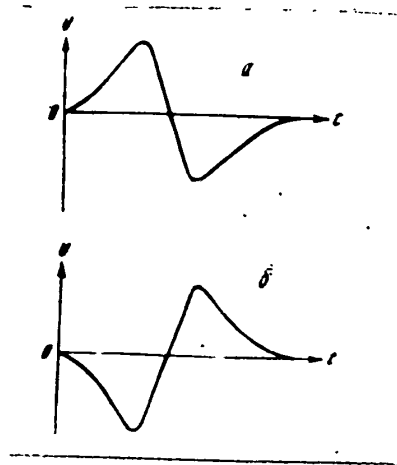


Fig. 9. Form of the Impulse of Voltages on the Reproducing Signal in the Windings of the Head.

a in 1st winding; b in 2nd winding

The total number of heads is 84, eighty of them being for codes, two synchronizing and two reserves. The code heads are divided into five groups of sixteen each. The recording and the reading of the numerical codes is possible, both within the limits of one path

(64 numbers), as well as with transition from one path to another within the limits of one group (1024 numbers). The heads are arranged in two parallel units with 42 in each. The heads are somewhat displaced with respect to each other along the generatrix of the drum, as a result of which the heads are arranged in staggered order, and each head has its own track. On the track of one of the synchronizing heads there are recorded the synchronizing pulses of the drum (SP-D), which determine the frequency of the device's work. On the path of the other synchronizing head, there is recorded the pulse which determines the beginning of the SP-D reading.

The calculation of the SP-D corresponds to the calculation of the angular displacements of the drum. By knowing the number of the SP-D which have passed since the beginning of the calculation, one can determine the place on the drum which in a given moment is under the head.

The maximum number of pulses on the circumference of the drum is 2,560 (with a recording density of 3 pulses for 1 mm). The number of code pulses along the generatrix (i.e., the number of code tracks is 80. In this way, the drum capacity amounts to 204,800 binary digits, which corresponds to 5,120 40 step binary numbers. The drum turns at 750 rpm. The linear speed is 13 m/sec. The maximum time for awaiting the first figure is equal to the time of one revolution of the drum, 80 m/sec. The average waiting time is 40 millisec. The 40 step numerical codes can be arranged on the drum by two methods:

a. All code steps are recorded or read simultaneously (parallel method);

b. The number is recorded on one path, step after step. After filling one path, the recording is transferred to the next one (consecutive method).

The time for selecting a number t_{sel} in the first method is 30 μ sec, and in the second, 1200 μ sec. Formerly, as the operative memory device of the BESM, a memory device was used based on electro-acoustic mercury tubes (MDM) with a maximum time of waiting for the selected code of 640 μ sec.

The time for selection of a number on the drum should be greater than the time of waiting for the number from the operative memory device. Therefore for working with the MDM, the parallel method of recording and reading on the MMDD was generally impossible. At present, the operative memory device of the BESM (IMD) is designed on the basis of electron tubes, and the time of selecting a number from the IMD amounts to 10 μ sec (at a working frequency of the BESM of 400 kcps). This makes it possible to select a code from the IMD in the parallel method of working of the MMDD.

For most of the problems solvable on the BESM, the average number of codes for one turn of the drum generally equals 200 or 250.

With the consecutive method, the time necessary for recording or reading the codes amounts to 360 millisec. Of this, 40 millisec. (time of a half turn of the drum) will be the average time of waiting, and 320 millisec. will be required for consecutive reading of

four tracks, since the reading of one track takes up 80 millisecc.

By the parallel method, the time of the operation of the exchange of codes is considerably shortened. The time required for reading 250 numbers is 47.5 millisecc. Of this 40 millisecc. is spent in waiting for the code and 7.5 millisecc. directly for the exchange of codes, i.e., with the parallel method, the exchange of code takes place in little more than one-eighth of the time.

However, on the rapid-action BESM, as a whole, the use of the parallel method has little significance. For the most of the typical problems solvable on the BESM, the time of exchange of codes with the drum makes up 8 to 10% of the whole. With the parallel method, this time could be about 1%. Thus the rapid action of the BESM would be increased by 7 to 9%, but the use of the parallel method would require considerably more equipment. The number of tubes would be about doubled. For each discharge, it would be necessary to have a separate reading amplifier and two recording amplifiers (recording code "0" and code "1"). For connecting with the BESM 40 times as many input and output tube elements would be required. On the standard 6.5-millimeter magnetic tapes used in the BESM, the parallel method of recording and reading would be altogether impossible. Therefore, for the work of the MMDD and MMDT, one would have to use different methods, which unconditionally would complicate the logic of the control circuit's operation, and lead to additional increase in size of the equipment.

Besides, with the parallel method of operating the drum, in the

case of mechanical breakdown of one track or one head, the capacity of the drum would be cut in half at once. With the consecutive method, however, damage to the coating of one track on the MB will reduce its capacity only by 1.25% altogether.

On the basis of the reasons which have been explained, the consecutive method of operation has been accepted for the device described.

2. CODE INPUT AND OUTPUT DEVICE ON THE DRUM (CIOU)

The CIOU device for the input and output of codes on the given tracks of the magnetic drum and for the input of the codes stored on the drum, consists of:

Recording amplifiers AR-MD (two amplifiers for each group for recording the codes "0" and "1");

Reading amplifiers AP-MD (one amplifier to a group);

Rectifiers, type V(b), for the recording amplifiers;

Rectifiers, type V (standard unit BESM) for the reading amplifiers;

Diodes for selecting the tracks in the reading channel, type Dv (one diode for each drum head);

Track-selecting diodes in the recording channel, type Da (standard unit of the BESM). The number of diodes for recording is equal to twice the number of magnetic drum heads, since the codes "0" and "1" are recorded through each head.

Track-selecting converters, 16 units (in accordance with the number of tracks in one group).

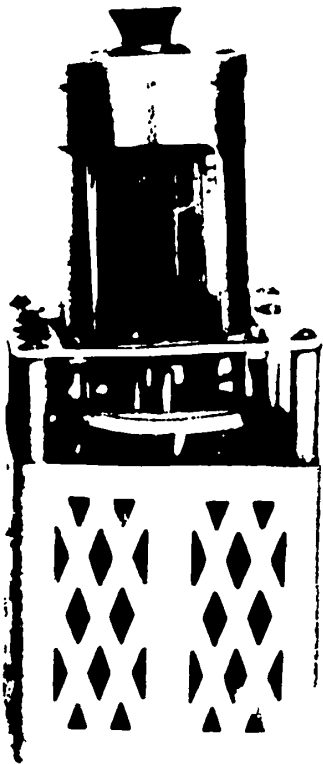


Fig. 10. Amplifier of the Recording of the Codes on the Drum AR-MD

In agreement with the number of heads, the surface of the drum has 80 tracks, which are divided into 5 groups with 16 tracks each. The selection of a given track in recording and reading is accomplished in two steps: selection of

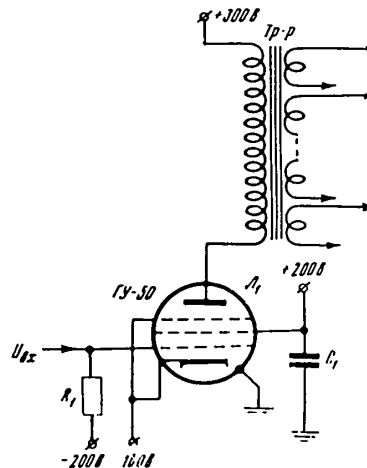


Fig. 11. Diagram Showing the Principles of the Circuit of the Amplifier AR-MD

the given tracks in all five groups and selection of the given group.

Before taking up the consideration of the working of the circuit of the CIOU, let us dwell briefly on the nonstandard elements used in the MMDD.

The recording amplifier AR-MD (Figs. 10 and 11), mounted on a standard two-way takedown frame, consists of a single-cascade amplifier on a powerful GU-50 pentode. A transformer is connected with 16 secondary windings to the anode circuit of the tube in accordance

with the number of tracks in a group.

Normally, the AR-MD tube is closed on the control grid by a voltage of 100 v relative to the cathode. In recording, a positive pulse passes to the grid with an amplitude of 120 v and a duration of 7.5 μ sec., which opens the tube and produces a voltage pulse in the secondary winding.

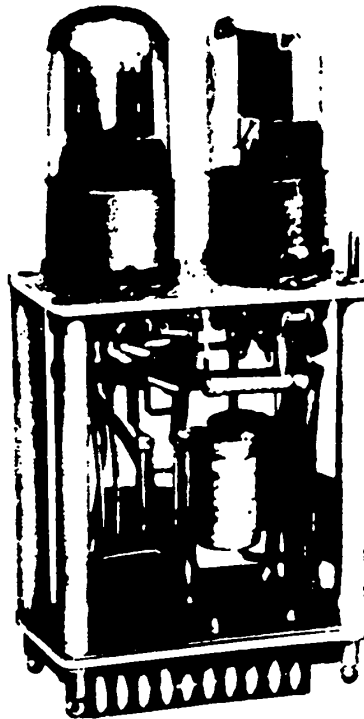


Fig. 12. Amplifier of Code Reading from the Drum AP-MD

The Reading Amplifier, AP-MD (Figs. 12 and 13) with four cascades on two double triodes, is mounted on a standard one-way dismountable frame. The first two cascades are assembled on the 6H9C (6N9S)* tube and work in class A. The third and fourth cascades are the shaping

*Tube designations in parentheses are translations (Translation Editor).

ones and are designed on the 6H8C (6N8S) tube. The third cascade works on the system of deep cutoff and does not let through parasitic pulses which remain on the drum after recording "0" in place of code "1". By regulating the voltage on the grid of the third tube, the sensitivity of the amplifier can be changed within broad limits. The fourth cascade works with the zero displacement on the grid, limiting at the expense of the cutoff, the pulses which pass to it. The output of the amplifier is passed directly to the third grid of the valve tube onto the control grid of which the strobe impulses pass. From the output of the valve in reading each unit code there is given out a shaped impulse which is standard for the BESM.

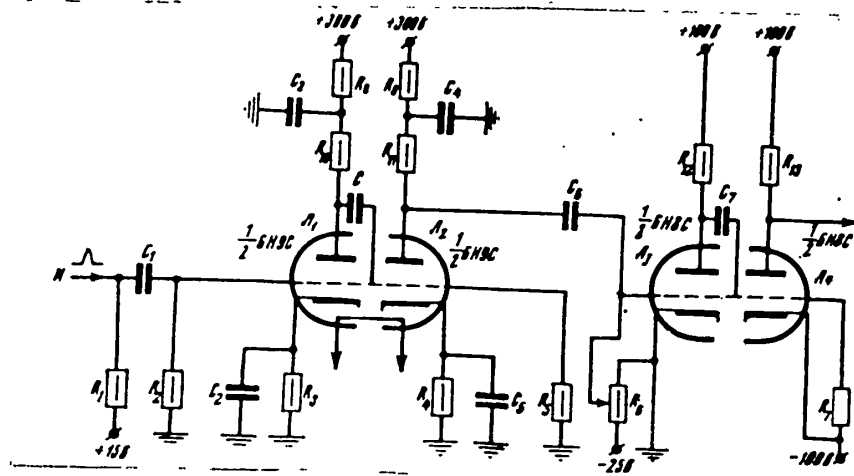


Fig. 13. Principles of the Circuit of the AP-MD Amplifier

In designing the amplifier, attention was paid to the time of the amortization of the circuit. After recording is finished on a given track, at the time of which signals of some tenths of a volt enter the

input of the amplifier, the command for the reading of the same group may follow at once. In reading, signals of an amplitude of tenths of a millivolt pass onto the input of the amplifier. The minimum time between the finishing of the recording and the beginning of the reading in the given case can be 150 to 200 μ sec. It is clear that during this time the amplifier must completely regenerate its capacity for amplifying weak signals. From these considerations, the time constants of the transition circuits are taken as being very small (of the order of 20 μ sec.).

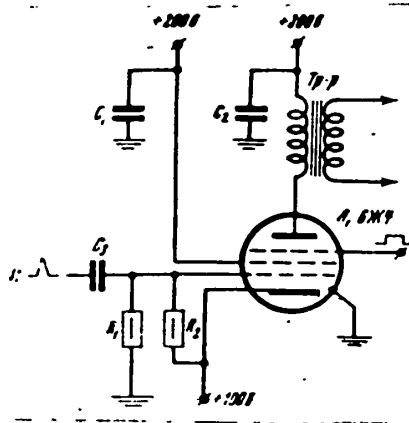


Fig. 14. Schematic Circuit of the Valve to the Amplifiers of Recording V(b) [B(b)].

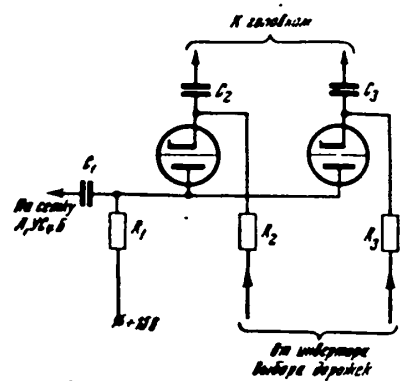


Fig. 15. Scheme of the Connecting of the Diodes Dv of Path Selection in Reading

The Valve* for the Recording Amplifiers V(b) (Fig. 14) is distinguished from the standard valves of the type V only by the parameters of its input circuit and the transformer designed for undistorted emission of square impulses of a length of 10 μ sec.

The Reading Selection Diodes serve to select a given track with-

*Translator's note: valve tube or rectifier.

in the limits of a group in the operation of reading from the magnetic drum. A simplified outline of the circuit of the unit Dv and an example of its connection are shown in Fig. 15. The number of diodes in the reading selection in the group is equal to the number of heads, i.e., sixteen.

All the diodes of a given group are connected by the anodes, onto which, through the resistance R_1 , DC + 15 v, is fed. Through the dividing capacitance C_1 from the anodes of the diodes, the signals to be read are taken and they pass to the input of the AP-MD. The cathodes of the diodes, through the resistances $R = 15 \text{ k}\Omega$, are connected to the anodes of the tubes of the inverters of the track selection. The control by the converters of the selection of the tracks at the output is effected from the commutator of the paths.

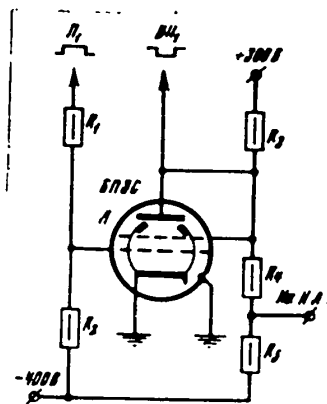


Fig. 16. Schematic Circuit of the Converter of the Path Selection

grid through the divider R_1 — R_2 . The resistances of the divider are selected in such a way that in selecting the output bar of the

The signals from the respective magnetic heads (from the recording windings of code "1"), pass onto the cathodes of the diode through the dividing capacitance, C .

The Inverter of the Track Selection

ID (Fig. 16) is designed on the tetrode 6P3S, connected by the triode. The cathode of the tube is connected with the ground. The voltage from the commutator of the paths passes onto the control

commutator, the voltage on the control grid equals zero and the tube is open and represents comparatively low resistance (1.5—2 k Ω).

The voltage on the anode of the converter falls to 7—10 v.

With the output bar of the commutator not selected, a negative voltage is produced on the grid of the tube, which is sufficient to black out the tube completely.

The change of the resistance of the tube and the voltage on its anode is used for control of the recording and reading diodes, depending on the control potential from the output of the commutator.

The selecting diodes corresponding to the tracks of the CIOU are connected to the anodes of the conductance tubes. A voltage of —300 v passes onto the tube through the anode resistance $R_3 = 100 \text{ k}\Omega$,

In this, on the anode of the open inverter, owing to a drop in the voltage on R_3 , there remain 7—10 v, but on the anodes of the remaining 15 inverters, —250—260 v.

3. OPERATION OF THE CIOU DEVICE IN RECORDING AND READING

In Fig. 17 there is shown the schematic circuit of one channel of the CIOU in recording code "1".* The high potential from commutator No. 1 passes through the divider onto the control grid of the tube L_3 of the inverter, which corresponds to a given path. The tube L_3 is opened, and its resistance is sharply lessened. The high potential from the output of commutator No. 2 opens the recording valve of a given group. In Fig. 17 this potential passes onto the third grid,

*The arrangement for connecting up the remaining channels is analogous.

L₁. The pulse passes to the valves of the recording amplifiers for code "1" or code "0", depending on the code from the control unit. From the recording valve V(b) the amplified pulse passes to the input of the amplifier for recording (onto the control grid L₂). From the secondary winding of the transformer, a pulse is passed to the windings of the magnetic heads. Into the circuit of the secondary windings of the transformer, the diodes are connected which are controlled by the potentials of the track selection inverters.

The recording pulse of current passes through the winding of the

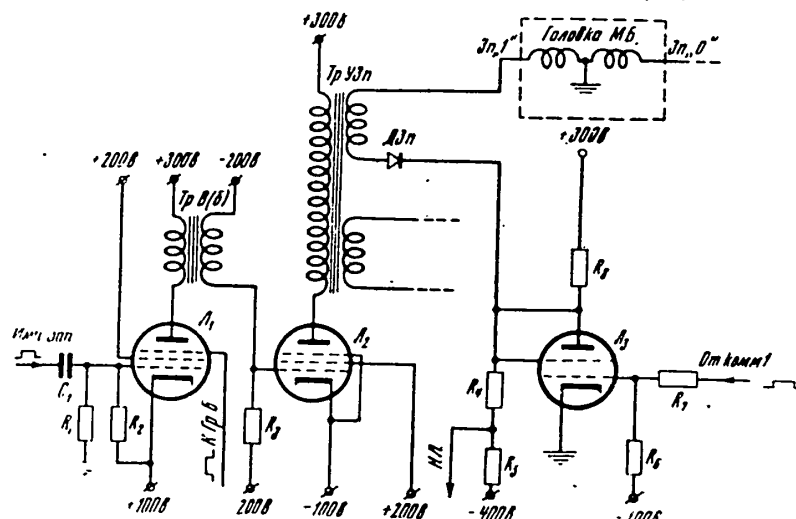


Fig. 17. Schematic Circuit of Channel of CIU during Recording of Code "1"

magnetic head only in the presence of two conditions:

- a. The inverter tube which goes into the circuit of a given winding should be open;
- b. There should be a voltage pulse on the secondary winding of the transformer of the recording amplifier of the drum head connected with the given winding.

Both conditions are fulfilled simultaneously only for one head of all those on the drum, and by virtue of this the selection of a certain track and the recording of a given code are accomplished. The diodes connected between the secondary windings of the transformers of the UZiB and the anodes of the conductance tubes fulfill the function of dividing elements. The dividing is necessary because onto one tube of the converter there are connected ten secondary windings of the transformers of the AR-MD (two from each group of the MD, one from AP"1" and one from AP"0").

In reading, the magnetic head operates on the circuit shown in Fig. 18.

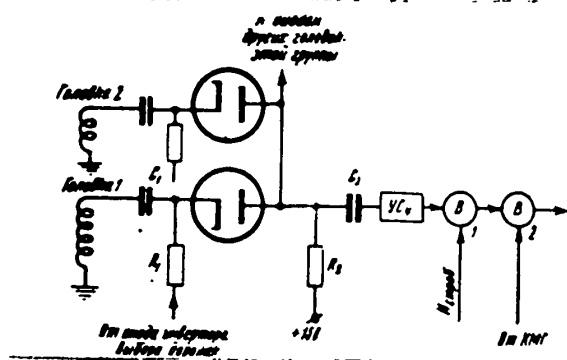


Fig. 18. Circuit of the Channel of CIUO in Reading
(R = resistance; C = capacitance)

The pulses read from the heads pass to the reading amplifier through the diodes. The reading amplifier alone is used for all heads of the group. The choice of the required head is accomplished with the aid of the reading diodes, the number of which in the group is equal to the number of heads, i.e., 16. Onto the combined anodes of the diodes there is fed a constant set by a voltage of -15 v.

The cathodes of the diodes are connected up through the resistances R_1 to the anodes of the inverters of track selection. As shown above, on the anode of an unselected inverter, there is a potential of 250-260 v. This means that the diodes of the unselected tracks will be closed, since the potential of the cathode is higher than that of the anode, and they will not let the pulses to be read pass from the magnetic head to the input of the amplifier. On the anode of the selected inverter, the potential equals 7-10 v. Therefore, the diode of the selected track will be open and the pulses from the selected head will go to the input of the reading amplifier.

The circuit described accomplishes the selection of the track within the group. Amplifying and shaping pulses from the output of USch (YCY) pass onto the grid of the third valve V_1 , but strobe pulses pass onto the control grid of this valve.

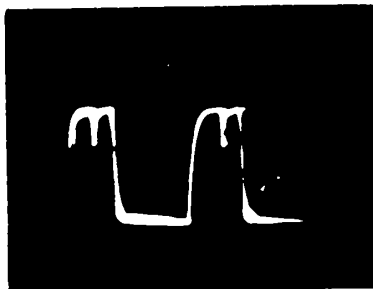


Fig. 19. Oscillogram of Pulses
1. Read (code "1") after amplifier; 2. strobe impulse

Fig. 19 shows an oscillogram of pulses passing to the input V_1 .

When pulses passing from the output of V_1 coincide, a signal is emitted.

Standard pulses shaped in this way pass from the output of V_1 to

the valve V_2 , on which, through the control by a third grid, the selection is made of the required group in reading. The control potential on V_2 passes from the commutator group—commutator No. 2.

CHAPTER III

Memory Device Using Magnetic Tapes
(MMDT)

1. MAGNETIC TAPE AND MAGNETIC HEADS

The use of magnetic tape as a memory element of the MMD is based on the known property of magnetic material, that of being capable of preserving two stable states. For recording and storing codes on the tapes in the MMD, one uses standard magnetic tape, type C.

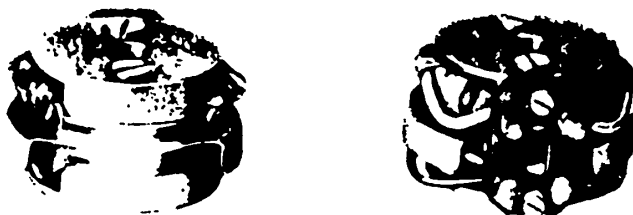


Fig. 20. Magnetic Heads DUMG-1 (ДУМГ-1)

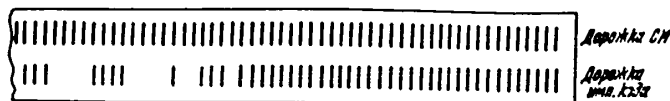


Fig. 21. System for Arrangement of Magnetic Codes on Magnetic Tape

The recording of pulses on tape and their reading is accomplished by the magnetic heads shown in Fig. 20. In contrast to ordinary sound recording, the magnetic heads used in the magnetic memory device are two-channel ones, i.e., in one unit of the heads, there are grouped two independent universal heads, separated by a magnetic screen. One of them is used for recording and reading the synchronizing pulses; the other is for recording and reading the

code pulses. Since recording on a magnetic tape is done consecutively (step after step), a picture of the recording is obtained as shown in Fig. 21.

For erasing, one uses a special erasing head (Fig. 22), located in front of the universal head (as the tape moves). When current is supplied to the windings of this head, both tracks are prepared (erased) at once for recording (SP and code).

The magnetic heads developed by the All-Union Institute for Sound Recording have the following specifications:

Recording and reproducing heads: Type DUMG-1; Material 80 NKhS; number of windings, 700×2 ; working gap, 20μ ; tail gap, 100μ ; wiring, PEV ($\Pi \rightarrow \beta$), 0.1 mm^2 ; gain, 3 mm; amplitude of signal emitted, 10—15 mv;

Erasing head: Type SG; material 80NKhS; number of windings, 500×2 ; working gap, 0.5 mm; wiring PESH0, 0.15 mm^2 ; inductivity, 90 ma.



Fig. 22. Magnetic Erasing Head, Type SG

In reading the signals recorded on the tape, the magnetized particles of the carrier pass under the slit of the magnetic head and induce an emf in it, whose magnitude is expressed by the general

formula stated above,

$$E = k \frac{d\phi}{dt}$$

In order to get a greater output from the heads, it is necessary to increase the $\frac{d\phi}{dt}$, i.e., in the final analysis, the magnitude ΔB and

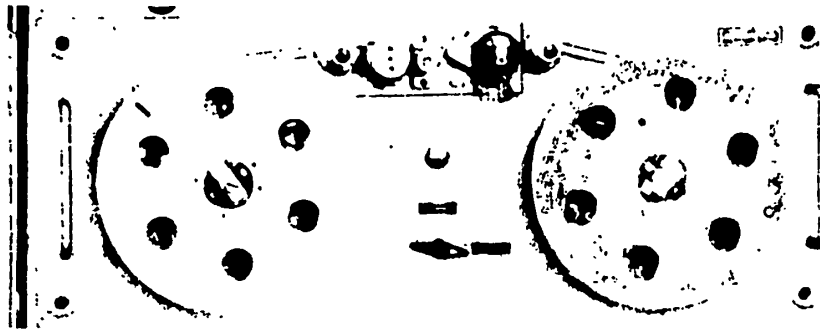


Fig. 23. Type B-2-52 Magnetic-recording Apparatus

the speed of movement of the carrier. However, on the one hand, the limit of increase of ΔB is the saturation of the magnetic tape, it is therefore important to have the tape at a sufficiently high speed, and, on the other hand, there exists a limit recording density (maximum number of pulses for 1 mm length of tape) at which it is still possible to distinguish two adjacent pulses. A further increase in the number of pulses per unit length of the carrier causes overlapping of the magnetized elements. A permissible recording density is 15 to 20 pulses per 1 mm of length. The recording density on the MMDT is 8 pulses per mm, which insures a completely dependable recording.

The magnetic recording apparatus, type B-2-52A (Fig. 23), was designed by the Institute of Sound Recording for MMDT, and provides a tape feed speed of 2 m/sec, which has a working sequence frequency

of pulses of 16 kcps.

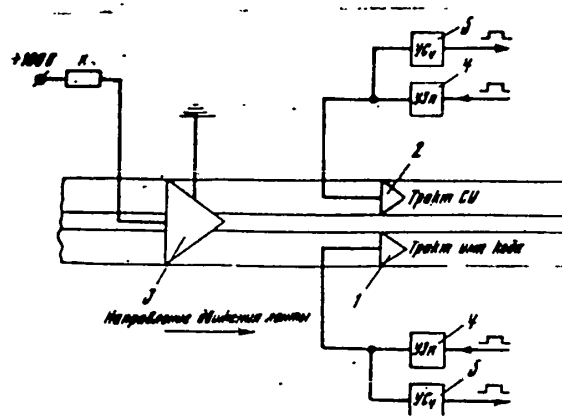


Fig. 24. Block Diagram of Recording and Reproducing System

1, code head; 2, head SI; 3, erasing head; 4, recording amplifier; 5, reading amplifier.

Fig. 24 shows a block diagram of the recording and reading system with the recording amplifier AP, and the reading amplifier RA for two channels in one apparatus.

2. ARRANGEMENT OF CODES ON THE TAPE

The recording of codes on the MMDT is done in the form of separate groups of figures, with intervals between each group, which is necessary for starting and stopping the tape (Fig. 25).

For each group, a definite number is adopted (code of the number of the group). The number of figures in each group can be arbitrary but must not be more than 1,024 (10 steps by the binary system of computing).

The use, in the MMDT, of four magnetic recording apparatuses

insures greater capacity for the memory device.

In the BESM, one operates with figures and commands which employ 39 steps of the binary system of computing. Therefore, the codes on the tape within the group are so arranged that on the first track, the synchronization pulses are recorded (SI), and on the second, the pulses of the code (Fig. 26).

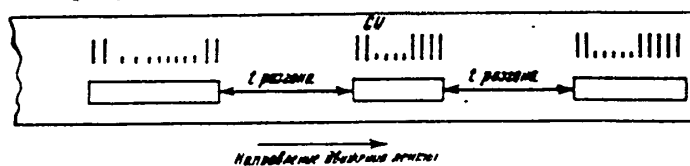


Fig. 25. Diagram of the Arrangement of Groups of Numbers on Magnetic Tape.

For every 40 synchronizing pulses, there may be 39 corresponding code pulses. The 40th pulse on the code track is not recorded. Therefore, an interval is formed between the numbers which corresponds to one synchronizing pulse.

For recording the code of a group number on the code track before each group, one uses the first six pulses on the code track, and on the synchronizing track, all 40 pulses are recorded in the code of the group number.

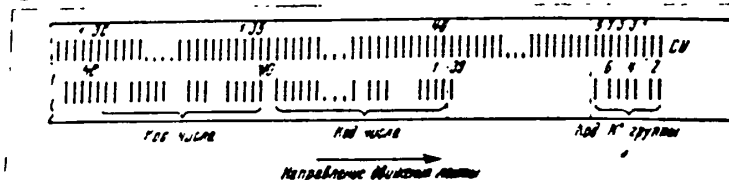


Fig. 26. Grouping Chart of the Codes on Tape.

The time of the coasting and stopping of the tape is determined by the time of the operation of the electromagnetic clutches of the

drive (250 to 300 millisec.), which is the time of their starting (about 100 millisec.) and also the time of the speeding up and stopping of the whirling (flywheel) masses of the reels on which the ribbon is wound (about 100 millisec.). In this way, feeding the current into the electromagnetic clutches amounts to 350 to 400 millisec., and the stopping time of the tape is correspondingly about 200 millisec.

3. ADJUSTING THE MAGNETIC HEADS

To insure the working together of all the devices of magnetic recording, i.e., to read on one magnetic tape recorder what is recorded on another, there are serious requirements for the magnetic heads and their adjustment (regulation).

These requirements basically have to do with a careful preparation of the magnetic heads, and the precise alignment of the parallel arrangement of the working slots of all the heads. The working gap of the magnetic head should not be curved; the working gaps of the synchronizing and code heads should be in a straight line.

In working with a tape, considerable recording density (one pulse for 125 microns), and noncoincidence in time of one pulse with respect to another should not exceed 10 to 15 μ sec. Therefore, the linear noncorrespondence of the working gap should not be more than 20 to 30 microns.

The lack of parallelness of the gaps causes a broadening of the pulse in reproduction and a lowering of its amplitude through a lessen-

ing of the speed of the magnetic flux change under the working gap. In view of this, for adjusting the heads on each apparatus, an adjustable base is inserted on which the head is mounted. As can be seen from Fig. 27, by turning the regulating screw, one can change the position of the magnetic head slot with relation to the tape.

For adjusting the heads on one apparatus, one records a whole series of pulses of the code and the synchronization at the working frequency, after which the tape with the recording is placed on another apparatus, the signals to be read are amplified, and they are fed directly onto the plates of the oscilloscope, whereby the synchronizing pulses go onto one plate and the code ones onto the opposite plate.

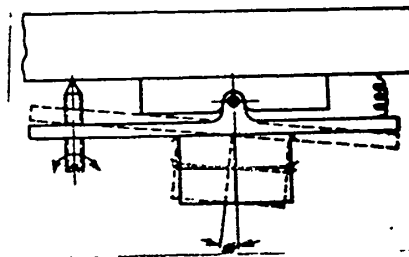


Fig. 27. Device for Regulating the Position of the Slot of the Head Together with the Head

Scanning is also started from the signals which are being read. By a slight turn of the regulating screw, one gets coincidence on the

oscilloscope screen of the code pulses and the synchronizing pulses.

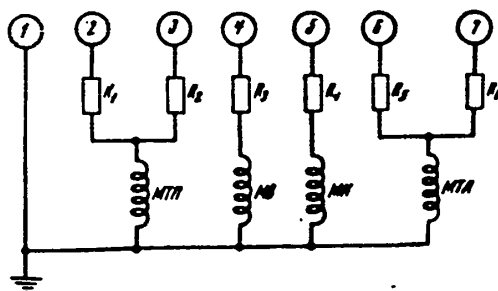


Fig. 28. Circuit for Connecting up the Electromagnetic Drives of the B-2-52A Apparatus

4. CONTROL OF THE STARTING OF THE TAPE DRIVE

Fig. 28 shows the circuit for connecting up the electromagnetic clutches of the drive of the B-2-52A

apparatus.

In the apparatus prepared for starting "forward" the right and left brake clutches MTP and MTL tighten up, for which a potential of 110 v is fed to the windings of these clutches through the resistances R_1 and R_6 . The clutch of the working motion MV and the clutch of the rewinding are shut off. In starting the brake clutches of the working stroke, it is necessary to shut off and feed the current to the windings of the working motion MV through the resistance R_3 . In stopping, one shuts off the clutch MV and the brake clutches tighten up. For this purpose, a potential is supplied through the resistances R_1 and R_6 .

In the apparatus prepared for rewinding, the brake clutches tighten when a current is supplied to their windings through the resistances R_1 and R_5 .

For connecting up the apparatus to the rewinding, it is necessary to shut off the brake clutches and supply a current to the clutch of the rewinding through the resistance R_4 .

In the process of operating the B-2-52A apparatus, it was necessary to stop using the electromagnetic brake clutches because of their defective design. The time of operation of the brake clutches was not constant, which more than once resulted in a slackening of the brake clutches and frequent breaking of the magnetic tape. At the present time, the braking is accomplished by mechanical brakes (by friction), and the clutches MTP and MTL are always shut off. With mechanical braking, the time of the coasting of the tape is somewhat

greater, which is undesirable. However, cases of breaking the tape during easy braking are rare, and this is very important since it increases the dependability of the work of the LMDT.

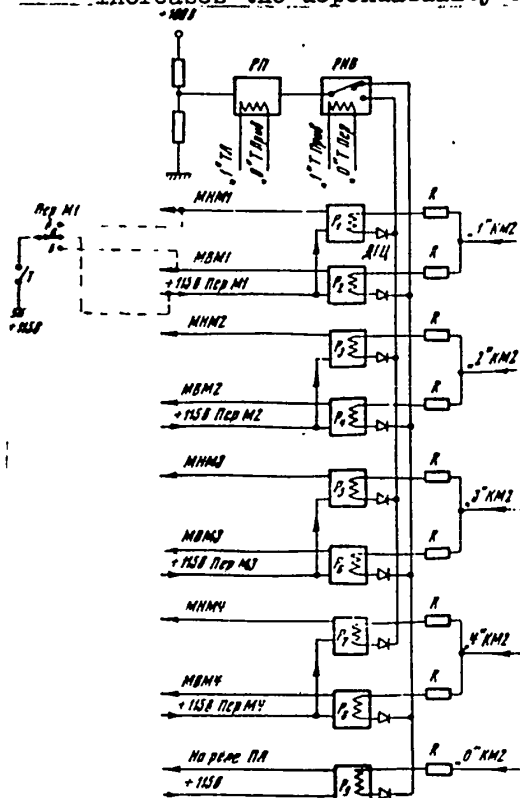


Fig. 29. Outline of the Circuits of the Connecting up of the Relays Which Control the Starting of the Drive of the Apparatus B-2-52A.

Fig. 29 shows the outline circuit of a connected-up relay controlling the starting of the B-2-52A apparatus drive.

The figure presents polarized relays of the RP-7 type.

The starting relay is controlled by a voltage from the anodes of the triggers: "1" TL (tape trigger) and "0" DT (drive trigger). Under the condition of the triggers as shown, the relay operates and connects in a voltage of about 20 v from the divider on the output contact of the relay of the direction of winding RNV, which has reversible contact. This relay is controlled by the voltages of the

triggers "1" DT and "0" TPer (rewinding trigger). Up to the command "rewinding", the rewinding trigger is in condition of code "0", the relay RNV is relaxed and contacts are closed at point a. A low potential is fed to the general control bar of the relays "forward": R_2 , R_4 , R_6 , R_8 , and R_9 . Onto the second terminals of the control

windings of these relays, voltages from the output of commutator No. 2 (commutator of the number of the magnetic tape) are supplied through resistances $R = 6.8$ kilohms. When a high potential is supplied from commutator No. 2, the corresponding relay operates, the contacts are closed, a voltage of +115 is supplied to the clutch for turning "forward" one of the magnetic tape recorders, and the selected tape starts to move forward.

On the command "rewind", the rewind trigger stops in the code "1" position, the PNV relay operates and throws over contact at the point b and a low potential from the divider is passed to the control bar of the "rewind" relay.

The second terminals of the control windings by these relays are also connected with the outputs of commutator No. 2 of the magnetic tape number. Since the circuit through the winding of the rewinding relay is closed, the relay, onto which a high voltage is passed from the commutator, operates. A voltage of +115 v passes through the contacts onto the clutch "back". The tape selected is started back and rewinds.

The tape is stopped if the trigger of the drive DT is placed by a command pulse in the position of code "0". Then the relay RP by its contacts breaks the circuit of feed of low potential to the terminals of the windings of relays R_1 to R_7 , and the circuit through the control windings of these relays will be interrupted.

For the device based on the perforated tape PL, automatic rewinding is not provided. The starting of the perforated tape forward is

accomplished through relay R_9 .

For convenience in checking the magnetic tape, besides the automatic (command) starting, a manual connection of the drive in any direction with the aid of a throw-over switch is provided.

The circuit for connecting the throw-over switch or commutator (Per M1) for the magnetic tape recorder No. 1 is also shown in Fig.

29. In the operating position, +115 v passes through the tumbler onto the throw-over switch at point a, and further onto the input contacts of relays R_1 and R_2 . When one of the relays is operating, the voltage will be fed to the corresponding clutch for turning and the tape is started. In the case of manual throw-over of the reversible contact at the point b or v, the potential of +115 v, passing the contacts of the relay, will be fed directly to the corresponding clutch of the turning and it will start the tape forward or back, depending on the position of the throw-over switch. In this case, as seen from the circuit drawing, the controlling voltage is not fed to the output contacts of the R_1 and R_2 relays. In case even one of these relays happens to be attracted, the voltage will not go to the turning clutch. In this way the simultaneous feed of voltage to the clutches for turning "forward" and "back" will be blocked, which would cause the magnetic tape to break.

5. DEVICE FOR INPUT AND OUTPUT OF CODES ON TAPES (CIOU-t)

The recording of codes on a magnetic tape and reading them from the tape is effected through the unit of input and output of codes,

CIOU-t. Besides the recording and the reading, with this unit the selection of tape is accomplished, as well as the shaping of the impulses, both for recording and reading.

The unit CIOU-t (Fig. 30) consists of the following elements:

Amplifiers of the recording of codes and synchronizing pulses of the USp (YCu);

Amplifiers of the reading of codes and synchronizing pulses of the USch (YCu);

Shapers of ten microsecond pulses for recording (single-movement multivibrators) M;

Valves, which simultaneously act as shaping elements;

Relays for coupling of corresponding amplifiers to the windings of the magnetic heads;

Auxiliary control tumbler.

In the unit CIOU-t for four magnetic tape recorders, there is one assembly of amplifiers: recording of code, recording of synchronizing pulses, reading of code, and reading of synchronizing pulses. The coupling of these amplifiers to the appropriate heads of the magnetic tape recorders is done through the relays' contacts. The relays of the amplifiers are also supplied with a voltage being delivered to the clutches for turning the reels of the magnetic tape recorders. In this way, simultaneously with the starting of the magnetic tape forward or backward, the head of a given magnetic tape recorder is also coupled to the input of the reading amplifier of the output of the recording amplifier, depending on the position of the inter-

mediate common relay R_5 of the potential-controlled trigger of the record in the control circuit of the LMD.

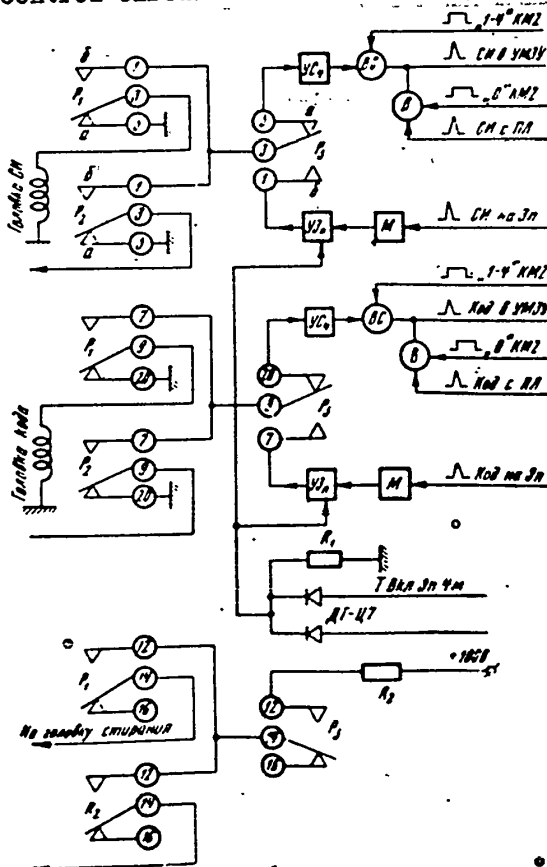


Fig. 30. Outline Circuit of the CIOU-t Unit for Two Magnetic Tape Recorders

For each magnetic tape recorder in the circuit, one relay* is assigned.

Simultaneously with the starting of the selected magnetic tape either relay R_1 or R_2 operates, depending on the number of the

*The circuit in Fig. 30 is for two magnetic tape recorders; the coupling of the remaining ones onto a uniting bar is analogous to this circuit.

magnetic head of the synchronizing pulses is coupled, assumes position b. Through the contacts 3 and 1, the head of the selected magnetic tape recorder becomes coupled to the common output bar, and through it onto the reversible contact of the relay of recording and reading, R_5 .

In carrying out the "read" command, the R_5 relay is released and its contacts, 3 and 5, are closed. The synchronization head of the selected magnetic tape recorder will be coupled to the input of the amplifier reading the synchronizing pulses.

In carrying out the command, "recording", the R_5 relay controlled by the potential of the recording trigger, operates and closes contacts 3 and 1. The magnetic head connects to the output of the recording amplifier of the synchronizing pulses. The other group of contacts of the R_1 or R_2 relays, through the contacts 9 and 7, connects (in an analogous way) the magnetic head of this same magnetic tape recorder to the input of the amplifier of the reading code or the output of the amplifier of the recording code, depending on the nature of the operation.

In recording a code on magnetic tape on which there is old recording it is necessary first to demagnetize, "erase", the old code. Every apparatus for this purpose has an "erasing" magnetic head. In the operation "recording" a voltage of +100 v passes across the contacts 14 and 12 of the relay R_5 , and further across the contacts of the R_1 or R_2 relays through an additional resistance onto the winding of the erasing head. Magnetic tape pulled under the slot

of the head is demagnetized by a constant magnetic flux and thereby old recording is "erased".

In the CIOU-t unit, nonstandard units AR-MT, AP-MT, and M are used.

The Amplifier of Recording on the Magnetic Tape, AR-MT (Fig. 31), intended for feeding pulses into the magnetic head, is designed on the tube 6Zh4 in the form of a single-cascade rheostat amplifier working in class C. Onto its input there pass from the multivibrator positive, square pulses with an amplitude of 50 to 60 v and a duration of $10 \mu\text{sec}$. From the output of the AR-MT onto the magnetic head, there pass negative pulses of an amplitude of 70 to 80 v. In Fig. 32 there is shown an oscillogram of the pulses of recording on the

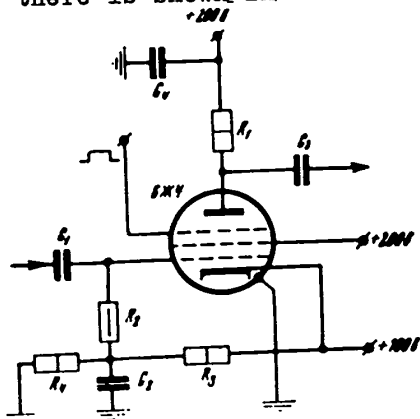


Fig. 31. Principles of the Circuit of the AR-MT Amplifier

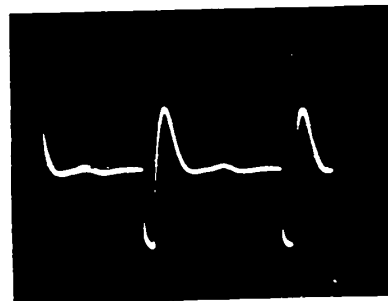


Fig. 32. Oscillogram of the Pulses of Recording from AR-MT on the Head

head. In recording, the control potential, "number of the tape", passes from the commutator No. 2 onto the third grid. By a high potential (+100 v) the AR-MT is opened for passing the recording pulse. When no application is made of the MMDT, as during the

operation of "reading", the third grid of the tube 6Zh4 is grounded and the tube is cut off since a voltage of +100 v is fed to its cathode.

The Amplifier of Reading from the Tape, AP-MT (Fig. 33) is intended for amplifying the signals received from the magnetic head in reading from the magnetic tape.

The AP-MT is a three-cascade amplifier, designed on the basis of the 6Zh8, 6Zh4, and 6Zh4 tubes. The third cascade is the shaping one and at the same time the valve, controlled in accordance with the third grid. In its construction, the third cascade is designed separately from the first ones and is located in the two-tube unit together with the tube of the recording amplifier.

Pulses which have a complex form and a duration of 25 to 30 μ sec at a frequency of from 0 to 16 kcps (16 kcps is the working frequency of the MMDT) and an amplitude of 15 to 20 mv pass to the input of the amplifier. There is no need for precise transmission, to the amplifier, of the form of the signal to be amplified, since the pulse is given the required form and duration in the shaping circuits. Therefore, the frequency curve in the region of frequencies above 30 kcps has a rather steep slope.

The first cascade of the amplifier, tube 6Zh8, works in class A and has a factor of amplification of about 50.

From the output of the second cascade, designed on the basis of the pentode 6Zh4, the signal passes to the shaping cascade, which, for greater dependability in shaping the pulses, works with the grid

currents. Therefore, the output power of the second cascade should be quite high. To this end, the anode resistance R_g is fixed comparatively low (22 k-ohm).

Since a pulse which has both a positive and a negative half passes onto the first cascade, in the second cascade the positive part is cut off through a grid current and at its output there appears a positive pulse of about 60 to 70 v.

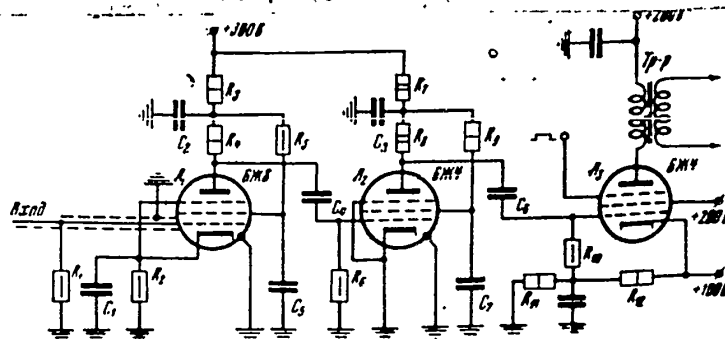


Fig. 33. Principles of the Circuit of the Amplifier of Reading from the Tape of the AP-MT

The common factor of amplification of the first two cascades is around 2,000.

The third cascade is a shaping valve, designed on the basis of the 6Zh4 tube. This valve is distinguished from the standard one used in

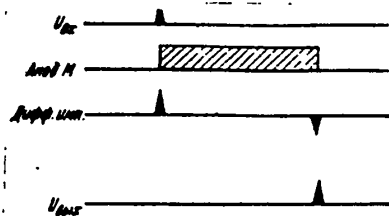


Fig. 34. Time Diagram of the Shaping of the Retarded Pulse

the BESM by the parameters of its grid circuit, changed in the direction of increasing the constant of time, since after the second cascade, pulses of greater length (up to 25 μ sec) pass onto its input than onto the input of

the standard valve. In order to avoid a lowering of the pulses' amplitude on the grid of the L_3 tube, the input capacitance is fixed at 10,000 mmf, and the dissipation resistance at 10,000 ohm.

On the output of the third cascade, due to the differentiating action of the anode transformer, a pulse is obtained which is standard in amplitude and length.

Multivibrators M (see Fig. 30) are used in the unit CIOU-t as shaping elements for obtaining square pulses of a length of 10 μ sec, needed for recording signals on the magnetic tape. Besides, the multivibrator is used in other circuits of the control of the MMD as a circuit for retarding pulses. For this pulse, which needs to be retarded, the multivibrator is started, and on its output there is obtained a square pulse of the required length. This square pulse is differentiated, and a pulse is used which is obtained with differentiation of the trailing edge. The time diagram of this process is presented in Fig. 34.

In Fig. 35 a representation is given of the principles of the circuit of the unit M. On the L_2 tube (6N8S), there is designed the circuit of a single-kick multivibrator possessing great stability in time retarding. The circuit R_8C_3 serves as the timing one.

The starting of the multivibrator is done through diodes L_1 (6 x 6) by feeding through them positive starting pulses onto the left half of the L_2 tube. To increase the resistance of the circuit to disturbances, both diodes are normally closed by a voltage of +20, which is supplied from the divider R_5-R_6 onto the cathodes of the

tubes. Onto the anodes of L_1 there passes a potential of +12 v through the dividers R_1-R_4 and R_2-R_3 . In this way, on the cathodes of the diodes, there is obtained a voltage of +8 v, relative to the anodes, and the tubes close to disturbances of an amplitude of less than 8 v. The working signal, the amplitude of which is 25 to 30 v, is passed through by the diode onto the input of the L_2 tube.

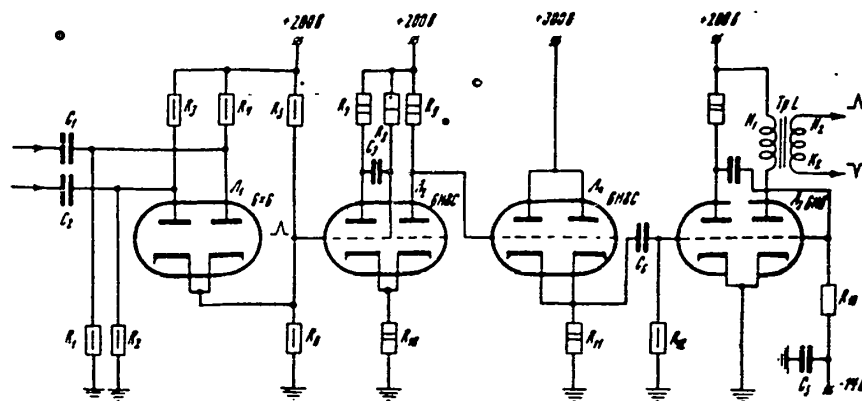


Fig. 35. Principles of the Circuit of the Nonstandard Unit, M

The tube L_4 (6N8S) is used as a cathode repeater, which serves for amplifying the power of the generated signals, and insures the stable operation of the multivibrator. Therefore, the shape and length of the generated signals does not depend on the magnitude and character of the load.

On the tube L_3 (6N8), there is designed the shaping cell for differentiating and amplifying the pulses in those cases where the M unit is used as a unit for retardation of pulses. A positive, square pulse of the duration of t_1 passes from the output of the L_4 tube onto the differentiating circuit C_6-R_{12} ; a negative pulse which corre-

sponds to the trailing edge of the square pulse, delayed (i.e., a negative pulse) relative to the starting pulse for the time t_1 , passes to the L_3 tube and is amplified. The right half of the L_3 tube is used as an amplifier with the transformer output, which enables one to get pulses of any polarity, and sufficient amplitude.

CHAPTER IV

Automation and Control of the MMD

1. COMMUTATION UNIT

The commutation unit consists of two commutators, commutator No. 1 (KM1) and commutator No. 2 (KM2).

The commutator No. 1 is the commutator of the tracks on the drum (CMD). It serves for controlling the choice of the track within the group and has 16 outputs (in accordance with the number of tracks in the group).

The commutator is designed on the diode circuit in accordance with the principle of shorting of circuits and represents the ordinary two-stage discriminator for 16 outputs. To increase the transmission, voltages from the anodes of the triggers are fed to the potential amplifiers (type Ia, standard unit BESM).

The circuit of commutator No. 1 is presented in Fig. 36.

From the outputs of triggers T_1 and T_2 across the potential amplifiers of the Ia, the potentials "1" T_1 , "0" T_1 , "1" T_2 , and "0" T_2 pass to the diodes and form the first group of the first stage of the discriminator. As a result of the combination of the positions of triggers T_1 and T_2 , any two diodes connected by anodes to one bar, become cut off in accordance with the cathode. One of the bars, 1, 2, 3, or 4, is under high potential +100 v. To each of these bars there are coupled four diodes of the second stage of the discriminator. For example, to bar 1 there are coupled diodes D_1 , D_2 , D_3 , and D_4 . An analogous circuit of the

second group of the first stage is formed by triggers T_3 and T_4 , with the potential amplifiers and diodes coupled to them. Depending on the position of triggers T_3 and T_4 , we always select (it is under a potential of +100 v) one of the bars, 1', 2', 3', or 4'. In exactly the same way, four diodes of the second stage of the discriminator are coupled to each of these bars.

The diodes of the second stage are so connected that if one of the bars, 1, 2, 3, or 4, and one of the bars 1', 2', 3' or 4', happens to be under high potential, then two diodes of the second stage of the discriminator are always blocked, and one of the 16 outputs of the discriminator (0000-1111) will be under high potential (+100 v). The tubes of the inverters of the tracks, the purpose and operation of which are described above (Chap. II, 2), are coupled to the output bars of the discriminator.

As an example, let us consider the case where code 1010 is on the triggers $T_1 - T_4$ (See Fig. 36), i.e., it is necessary to select the 10th track of the drum. Under these circumstances, bar 2 of the first stage of the discriminator and bar 2' of the second group of the first stage of the discriminator will be under high potential, diodes 7 and 27 will be blocked off, and the output bar 1010, 10th, will be selected.

The remaining output bars of the discriminator will be under low potential, about +30 v. On the output of the commutator (output of the inverters of the ID tracks) the selected bar will be under a low potential, +7-10 v, and the rest of the 15 bars, under a high potential, +250-260 v.

Commutator No. 2 serves to select a given group on the magnetic drum of the number of a magnetic tape recorder when using magnetic tape.

The principle of the circuit's design is the same as for commutator No. 1.

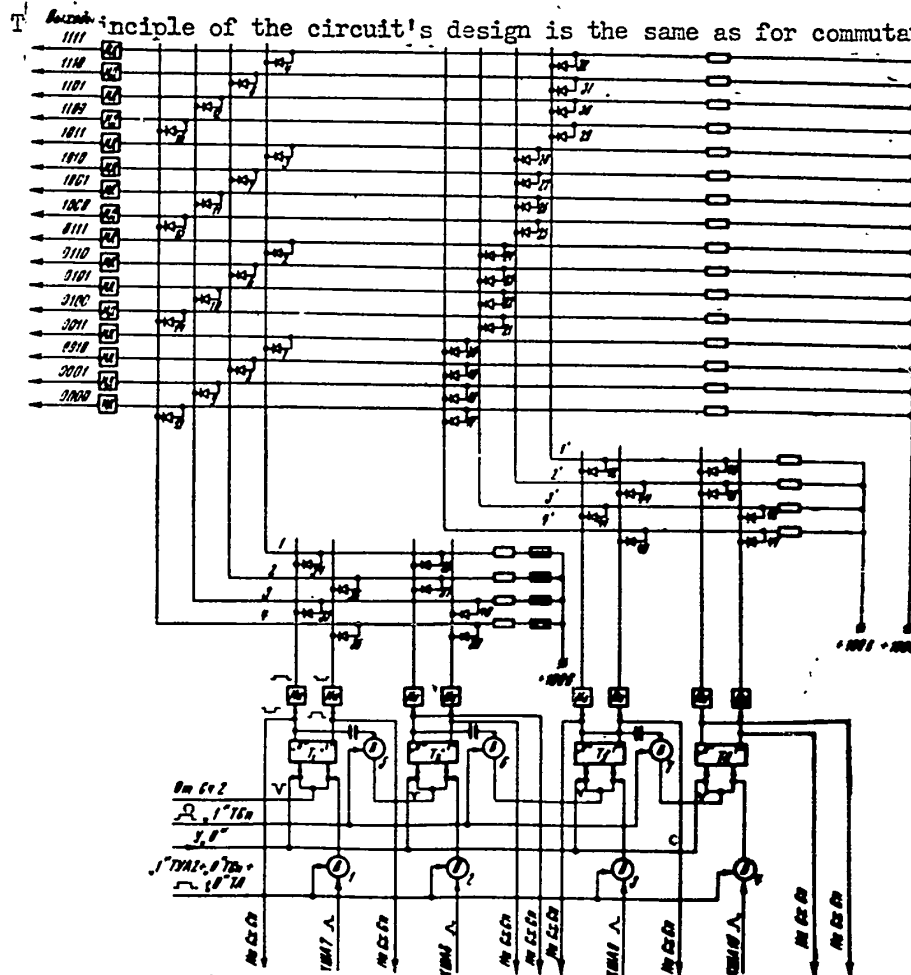


Fig. 36. Outline Circuit of the No. 1 Commutator

Commutator No. 2 is assembled in accordance with the single-stage circuit (Fig. 37). To insure a symmetrical load on the potential amplifiers of the Ia type, the discriminator is mounted on 8 outputs, but only 5 of them are used. Powerful cathode repeaters of the Ka type

(standard unit BESM) are mounted on the used output bars of the discriminator. Control from commutator No. 2 is effected by a high potential of +100 v. On the unselected bars the potential is low (+30 v).

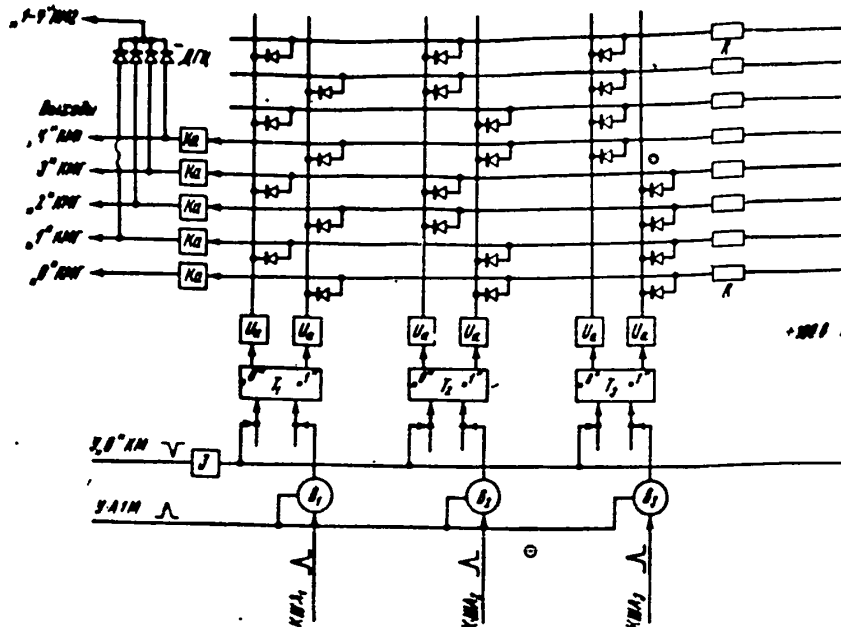


Fig. 37. Outline Circuit of No. 2 Commutator

2. UNIT OF THE COUNTERS

The Binary Electronic Counters M-D serve to register the synchronizing pulses on the magnetic drum and magnetic tape, and also to register the number of codes on the drum tracks. In working with tape, the counters register the number of codes in the group.

Counter No. 1 of the Synchronizing Pulses (C-SP1) fixes each 40th pulse, which determines the end of one code, written or read from the magnetic drum or magnetic tape, or from the device of the input of the perforated tape.

To simplify the circuit of the MMD, to every 39-step code received in the BESM, there correspond, not 39, but 40 synchronizing pulses.

Besides fixing each 40th pulse, the C-SPl has an output of the 7th pulse (I7) by which checking (of the coincidence of the code to the number of the group read from the tape with the one given in the command) is effected.

The counter of the synchronizing pulses, a regular binary counter with feedback, is designed on standard units of the BESM (triggers and valves) and germanium diodes.

An outline of the counter of the synchronizing pulses is presented in Fig. 38. Here the T_1 — T_6 triggers are coupled in accordance with the computing circuit, i.e., so that each pulse, passing to the input of the trigger, changes the condition of the latter to the opposite, throwing the trigger over into the position of code "1" if it had been in the position of code "0", and vice versa, if the trigger had previously been in the position of code "1".

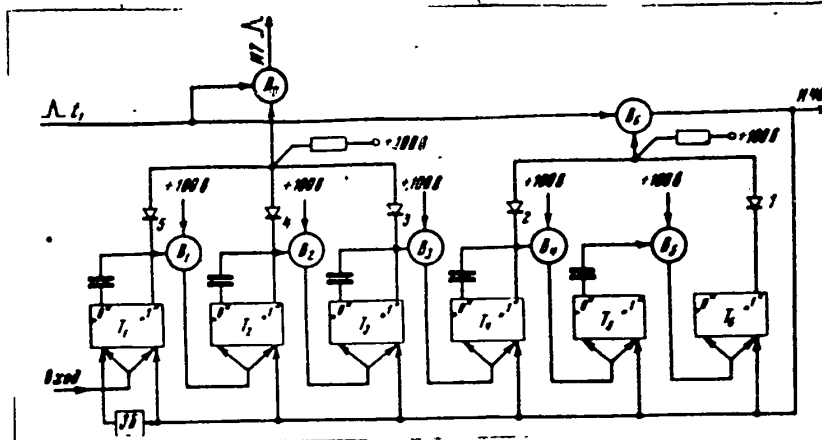


Fig. 38. Outline Circuit of No. 1 Counter of the Synchronizing Pulses

As transference elements, standard valves V_1 , V_2 , V_3 , V_4 , and V_5 are used. From the output "0" of each trigger, the voltage gap is differentiated and passes through the amplifiers onto the computing head of the trigger of the following step. In the changeover of each trigger of the lower step into the position of the code "0", there appears a pulse of transfer into the following higher step.

On conversion of the SP (synchronizing pulses) to 40 in the counter, feedback is introduced, brought about through valve V_6 and diodes D_1 and D_2 .

Every 40th pulse proceeds through valve V_6 at the moment when the triggers of the counter happen to be in the position of code 101000 (number 40 in the binary code). At this time, the valve V_6 in accordance with the potential input, is opened by the potential +100 v and emits a pulse, which constitutes the 40th synchronizing pulse retarded by $2.5\mu\text{sec}$ (there is enough of this time with reserve for changing the condition of the counter's triggers after the 40th SI).

Since the C40 is designed on 6 triggers, which by binary computing form a system of computing by 64 times, it is necessary by each I40 (40th pulse) to set the counter in the initial position (position of the code "0"). For this, the I40, through valve V_6 , passes onto the bar of the setting "0" of the C40.

Setting the C40 in the position of code "0" is accomplished through feeding a negative pulse to all outputs of the T_1 — T_6 triggers, through which they are set in the position of code "1". This same pulse, delayed for $0.8\mu\text{sec}$ is fed to the input of the T_1 setting into

the position of code "0".

In the changeover of T_1 into the position of code "0", a transfer pulse passes onto the input of T_2 ; T_2 , in changing to the position of code "0", produces a pulse of transfer onto T_3 , and so on until all triggers of the C40 are set in the position of code "0".

As shown above, besides the 40th pulse, in the C-SPl, there is also an output for the 7th pulse (I7). Each 7th synchronized pulse is given out from the output of valve V_7 of the output controlled in accordance with the input of the diode circuit of coincidence into the control circuit of the MMD.

Counter No. 2 (C-MD2) in working with the MMD fixes the number of the code. One can store 64 numbers on one track of the drum; therefore, the counter is intended for conversion to 64.

When working with the MMDT or with perforated tape, the C-MD2 serves for recording and reading the code of the group's number and computation of the quantity of numbers which it is necessary to record on, or read from, the tape.

During recording and reading of the code of the group's number, the C-MD2 works on the system of register with shift until the C-SPl emits the pulse I7. After receiving the I7 (7th pulse), the control circuits of the MMDT connect the elements of the C-MD2 for working the counter which registers the quantity of numbers in the group.

An outline circuit of the C-MD2 is shown in Fig. 39.

The design of the C-MD2 for the system of computing is analogous to that of the C-SPl, and is distinguished from it only by the fact

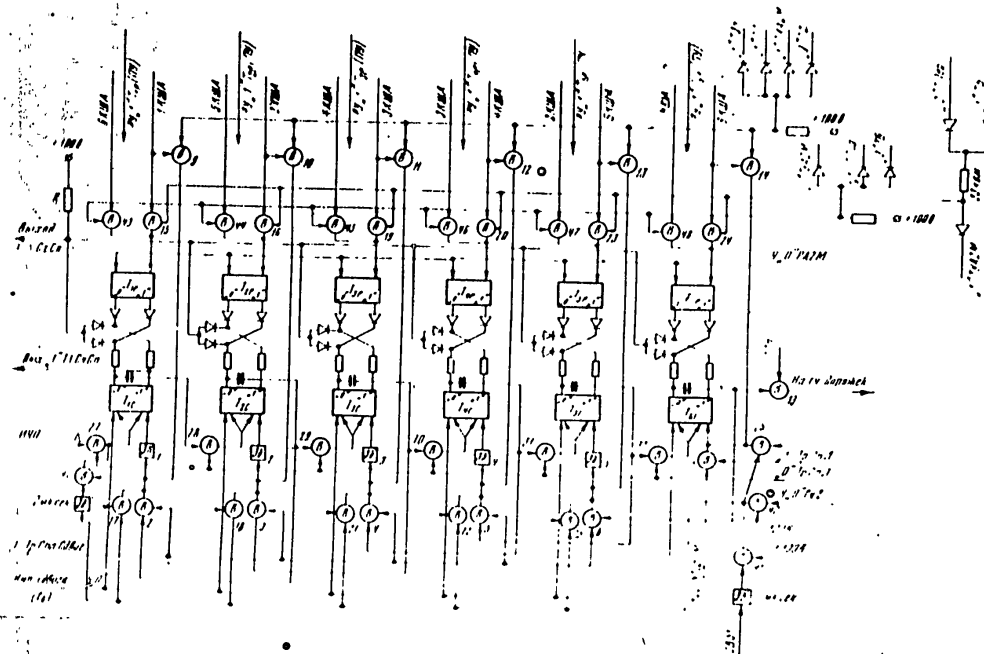


Fig. 39. Outline Circuit of No. 2 Counter

that for conversion to 64 times, feedback is not required as it is in conversion to 40 times.

The C-MD2 has 6 steps (triggers T_1 — T_6). As to step amplifiers of the counter (they are really valves), this function is performed by valves V_{27} , V_{28} , V_{29} , V_{30} , V_{31} , and V_{32} . In the system of computing, onto the potential inputs of these valves there is fed a high potential, +100 v, "calculation". Onto the computing input of the trigger T_1 , there pass the pulses I40 from the output of C-SF1.

The pulses of transfer from step to step in computing are formed by the differentiation of the voltage jumps from the triggers with their subsequent amplification on the transfer valves.

Code "1" is put on the C-MD2 after the indication (by the No. 1 counter) of the succeeding number on the tape or the succeeding number on the drum track.

All the outputs of the triggers of the C-MD2 are coupled to the circuit of coincidence. The output pulse I64 from the C-MD2 is taken across the valve V_{33} and passes onto the input of the succeeding computer, the C-MD3.

Setting the C-MD2 in the position of code "0" is effected by the feeding of the pulse through the valves V_{17} , V_{18} , V_{21} , V_{22} , V_{25} , and V_{26} onto the inputs of the triggers T_1 — T_6 which stop in the position of code "1". This same pulse, retarded by 2 μ sec passes through valve V_{42} to the calculating input of the Trigger T_1 , which, being shifted into the position of code "0", produces a transfer pulse onto the T_2 trigger. The latter is shifted into the position of code "0" passing

a transfer pulse onto the trigger T_3 , etc., until all the triggers of the C-MD2 are in the position of code "0".

When working with magnetic or perforated tape, at the moment of recording or reading the code of the number of the group, the C-MD2 works as a register with shift.

By feeding a low control potential onto the bar "calculation", the computing circuits are broken. A high potential passes onto the potential inputs of the displacement valves V_2 — V_7 "shift".

In the sender, there is used the circuit of shift from high steps to low ones. The control of the shift is effected in accordance with two circuits going from the circuit of control of the MMD—in accordance with the potential circuit "shift", and the pulse circuit—shift pulse (setting the triggers T_1 — T_6 in the position of code "0").

In the operation "recording", the code of the group's number passes through the valves along the commutation code bars of the address (CBA) onto the trigger of the C-MD2. During this, the shift valves are opened by the control potential "shift". When the pulse is fed onto the setting bar in "0" position of code, the triggers are shifted. On the outputs of the triggers, which up to this time have been in the "1" position of the code, there is formed a transfer pulse, which passes through retardation Z_b ($t = 0.8 \mu\text{sec}$) onto the input of the setting of code "1" of the succeeding lower step (discharge). After each shift pulse, the code present on the C-MD2 is shifted by one step in the direction of the lower steps. After six pulses of shift, the C-MD2 is freed from the code of the group number. From the output of the code

"1" of T_1 , the potential passes into the circuits of control of the MMDT and, depending on the position of this trigger, pulses corresponding to the code taken on the C-MD2 enter the circuit.

In reading the code of the group number, the C-MD2 works by the shift system as in recording. But in this case the code of the group number passes to the C-MD2 at its highest step through valve V_7 . After six pulses of shift, the code of the group number is received on the C-MD2.

Counter No. 3 (C-MD3) is intended for counting the numbers of the tracks within the limits of one group of a magnetic drum (see Fig. 36) and has 4 steps (for conversion into 16 times, the number of tracks in a group).

The circuit design of the C-MD3 is analogous to those of the C-SP1 and C-MD2. In contrast to the C-SP1 and C-MD2, which register respectively the passing of the code and number of the codes on the track, irrespective of whether recourse is being had to the MMD or not, the C-MD3 works on the system of a counter only when exchange of codes is taking place directly, i.e., after coincidence of codes on the C-MD2 and registry of addresses. Up to the moment of coincidence, the computer works as a register, the transfer valves are closed, and on the triggers there is the code of the current number of the track. Adding "+1" to the computer means transferring to the next consecutive track. The outputs of all discharges of the computer, both code "1" as well as code "0" are connected with the circuit of coincidence where the code of the track number on which recording or reading should cease is equalized with the code on the register of the second address of the RA2M.

When working with magnetic and perforated tape, the circuit of the C-MD3 becomes, as it were, the continuation of the circuit of the C-MD2 for counting the number of codes in the group.

3. REGISTERS OF ADDRESSES BY THE MMD

The register of the first address by the MMD (RALM) serves, when having recourse to the MMD, for interval remembering of the code of the first address. It is a unit consisting of cells of triggers and input valves, onto the inputs of which there are connected commutation code bars of addresses (CBA) of the BESM.

In accordance with the potential input, these valves are controlled by a gate pulse of the RALM* coming from the control circuit of the BESM. Onto their pulse inputs, there passes the address code from the AlMCU** and it sets the triggers of the corresponding discharges in the "1" position of the code.

The code passes onto triggers T_1 — T_3 (see Fig. 37) through the input valves B_1 , B_2 , and B_3 from the CBA. This code determines the number of the group on the magnetic drum, or the number of the magnetic tape recorder, to which recourse shall be had. The outputs of these triggers work on the discriminator of the commutator described above, No. 2. The code from the CBA of the 9th discharge (see Fig. 41) passes through the valve V_{57} onto the input of the trigger, TD, which determines the sign for recourse to the magnetic drum. The code from the CBA of the

*PALM = Transmission of first address during recourse to MMD

**AlMCU = First address of memory command unit

8th step passes through the valve V₅₉ and arrives at the input of the trigger, TT which indicates that the operation should be performed with the tape. The 10th discharge of the CBA is coupled to the RRT (Recording and Reading Trigger) which indicates the nature of the operation on the drum or the magnetic tape (recording or reading). The CBA of the 7th step is coupled through the valve V₆₀ to the input of the trigger of the rewinding (TRew). The position of this trigger determines the direction of the turning of the magnetic tape recorder selected.

The potentials from the outputs of the triggers TD, TT, RRT, and TRew are used in the control circuits of the MMD.

The register of the second address of the MMD (RA2M) serves as a memory of the second address in exchanging codes of the MMD with the IMD or DMD, and is a 10-step one, in accordance with the number of CBA of the BESM. Each step of the RA2M consists of a trigger and an input valve.

In accordance with the potential inputs, the input valves are controlled by the trigger which in turn controls the second address of the MMD (TS2A) to be found in the control circuit of the MMD. Corresponding CBA steps of the BESM pass to the pulse inputs of the valves. On the command CR from the A2MCU, there pass to the triggers RA2M the code of the address of the number of the place (1st—6th discharge) and the code of the track number (7th—10th discharge), from which the operation of exchange should be begun. In the command CPS, after the coincidence of the code position on the drum with the code on the RA2M has occurred, and the operation of direct exchange of code has begun,

the RA2M stops in position "0". By the pulse of TC-2* out of the MDD control circuit from the A2MCU**, there is issued onto the RA2M the code of the number of the position and the number of the track on which the operation should be finished.

When working with the MMDT on the command CR onto the RA2M by the CBA, there passes the address which determines the code of the number of the group coming in for recording or reading. On the command GPS by the pulse TC-2 from the A2MCU onto the RA2M, the code is issued which indicates the number of figures in a given group.

4. CIRCUIT OF COINCIDENCE OF CODES (CC)

The purpose of the coincidence circuit (Fig. 4) is the lining up of the codes on the C-MD2 and C-MD3 counters with the codes on the second register of address of the MMD (RA2M) and signaling in case of their coincidence. On the output, the coincidence circuit supplies a potential (high or low), depending on the position of the corresponding triggers in the RA2M and on the C-MD2 and C-MD3 counters.

This potential is used in the circuits of the MMD control network.

The CC is designed on the resistances $R_1 = R_2 = 33$ kilohm and the

* TC-2 = the transmission of the second address

**A2MCU = second address on the memory command unit

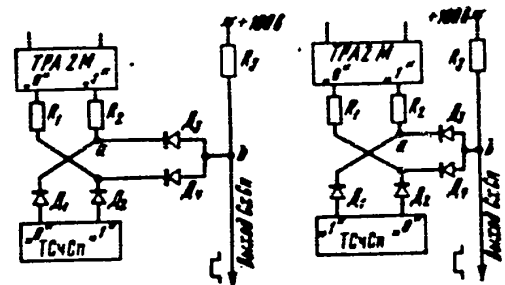


Fig. 40. Diode Circuit of Coincidence of Codes for One Discharge

I, coincidence; II, noncoincidence

germanium diodes D_1 , D_2 , D_3 , and D_4 of the DGTs-7 type. The resistance R_3 is common for all discharges of the coincidence circuit. The selection of the magnitudes of the resistances $R_1 = R_2$ and R_3 is conditioned by the necessary magnitude of the jump in voltage on the output of CC permissible for the tube with respect to current and time of the circuit's operation.

In the circuit of Fig. 40, I, a case is shown of coincidence for one discharge.

Both triggers, TRA2M and TSchSp, find themselves correspondingly in identical position. Let us assume that a high potential on the outputs corresponds to code "1". If on the TRA2M at the point "1" there is a high potential of +100 v then at the point a the potential will also be equal to +100 v, because of the great magnitude of the back resistance of diode D_1 . Consequently, the potential on the cathode of diode D_3 is equal to the potential on the anode D_3 . The current does not flow through the diode D_3 . Therefore on the output "1" of the TSchSp, the potential is high and at the point b there will be the same potential. The direct resistance of the diode constitutes a small amount in comparison with the resistance R_1 , and practically all voltage at the point "1" will be applied to the cathode of the diode D_4 .

At the diode D_4 , the cathode and anode will be under equal potential. Both diodes D_3 and D_4 will be blocked. Therefore a drop in the voltage on R_3 is not produced and on the output of the CC there will be given out a high potential.

Fig. 40, II shows a case of noncoincidence.

Let us assume that the triggers TRA2M and TSchSp are in different

positions. As is seen from Fig. 40, II, at the point a there will be high potential, since in the positions of "1" on the TRA2M there is high potential. The diode D_3 is shut off and does not let current through. The cathode of diode D_4 is under low potential (low drop in voltage on the trigger is +30 v). Consequently, along the circuit with a voltage of the source of current of +100 v, through the resistances of the diode D_4 and the cathode resistances of the tubes of the cathode repeater, a current will flow. On the R_3 , a drop in voltage will occur, and from the output of the circuit, a low potential will be given out.

5. ELEMENTS OF THE MMD CONTROL CIRCUIT

In the operation of exchanging codes between the MMD and an internal memory device (IMD), the whole control of the BESM, beginning with the moment of entry of the command pulse for solution of coincidence (SC) of the MMD, which simultaneously stops the central control of the BESM, is effected from the MMD.

The circuit (outline) of control of the MMD presented in Fig. 41 is composed basically from standard units of the BESM, triggers, valves, and amplifiers with retardation of the type 3v. Besides the standard units, in some circuits as an electronic retarder, the multivibrator M is used.

The separate elements of the circuit have the following designations:

TS2A—trigger for setting the second address of the MMD. This serves to open the input valves of the RA2M on receiving the code from the A2MCU.

During the time of one recourse to the MMD, the trigger TS2A twice controls

the receipt of the code on the RA2M. On the command CR from the central control of operation of the BESM, pulse I2 for the setting "1" of the TS2A is given out and is retarded by $1\mu\text{sec}$. The trigger TS2A through the valve V_{38} is set in the position of code "1", and by a high potential it opens the input valves of the RA2M V_{35} .

TI40--trigger of the 40th pulses. This separates the end of one code from the beginning of the following one during recourse to the MMD. To each code there correspond 40 synchronizing pulses (P), and the TI40 registers the passing of all 40 synchronizing pulses. The trigger finds itself in the position of code "1" between the 40th and the first synchronizing pulses.

The potential of the TI40 is used for giving out the control pulses from the MMD into the BESM at the moment of exchange of codes.

CST--trigger for solving the coincidence of the tapes. This serves to permit the beginning of the operation on the MMDT. The pulse I15TsU, on the command CFS, stops the working of the central control of the BESM and sends to the MMD a pulse for solving the coincidence (SC). During the operation "recording", a pulse of SC passes to the input of the multi-vibrator M_3 . It is retarded long enough for the activation of the magnetic tape. Passing through the valve V_{32} , it stops the SCMT in the position of code "1". During the operation of "reading" the CST stops in the position of the code "1" a little sooner (retardation time M_4 is less than M_3), so that the work of the control circuit may begin with definite anticipation of the moment when the group to be read comes up to the magnetic head.

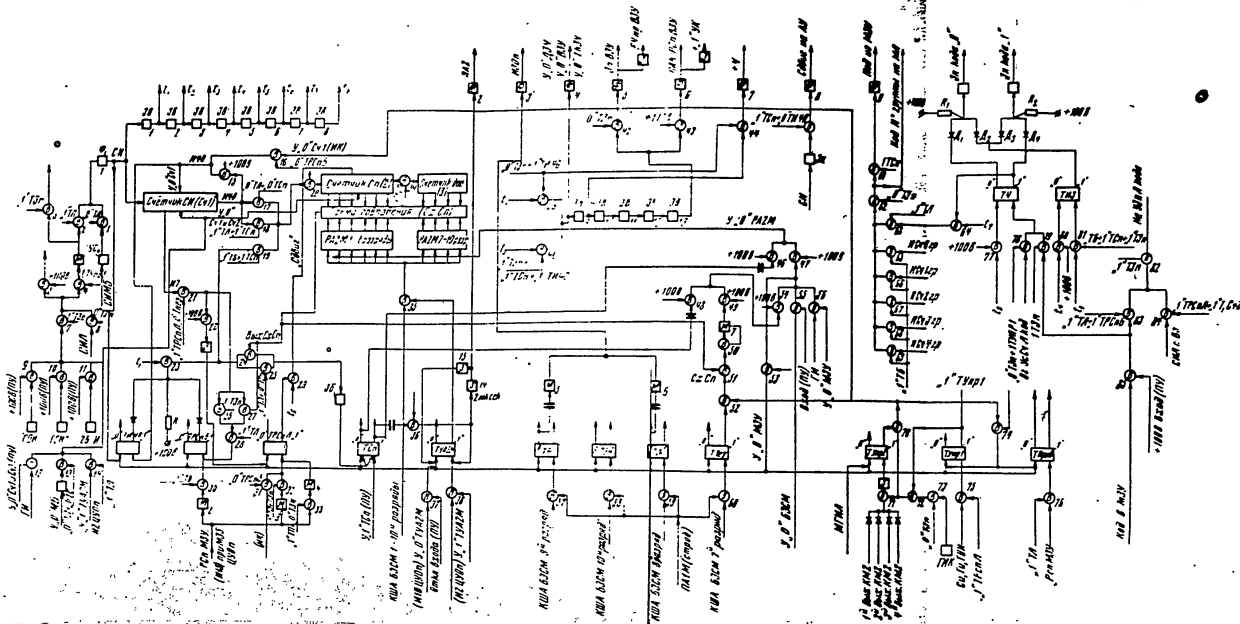


Fig. 41. Outline Control Circuit of the MMD

On the register of the second address, there is received the code of the number of the position on the drum whence the exchange of codes should begin, or the code of the group's number which should be recorded or read from the magnetic tape.

At the moment of the pulse $I_{TOT}U$ from CCOP there passes to the input of V_{37} the pulse of the setting "0" of the TS2A, and the latter is set in the position of the code "0".

On the command CPS after coincidence of the codes, the CT is shifted into the position of the code "1". The jump in the voltage produced at this moment is differentiated and fed to the inputs of the valves V_{36} and V_{46} .

From the input of V_{46} , the pulse formed passes into the circuit U "0" of the RA2M and puts the triggers of the RA2M in the position of code "0".

From the input of V_{36} , a pulse passes to the input of TS2A and places it in the position of code "1". By a high potential of the TS2A, the input valves of the RA2M are again opened. This same impulse, retarded by $2.5 \mu\text{sec}$ through F_2 (Φ_2), is passed into the CCOP in the form of a command pulse of the TC-2 (intake of the second address) and produces the passing to the CBA of the code from the A2MCU. Onto the TA2M there passes the code of the number of the place on the magnetic drum where the recording or reading should stop. When recourse is had to the tape on the RA2M, a code is received indicating the number of figures in the group. Finally, the same pulse passing through the retardation Zv_{15} , puts the TS2A in the position of code "0".

The potential of the TRSpL is used for the changeover switching of

the system of working of the C-MD2. In recording or reading the number of the group on the tape, the C-MD2 is coupled in as a shift register. By the high potential "1" of the TRSpL, the shift valves V_2 -- V_7 (Fig. 39) are prepared for working on "shift". By the passing of the shift pulses through the valve V_{29} the potential of the TRSpL is also controlled. Besides, the potential "1" of the TRSpL, through valve V_{75} , controls the setting of the TUprl in the position of code "1". The TRSpL is set in the position of code "0" through the valves V_{21} and V_{22} by the pulse I7, i.e., when the recording of the code of the group's number is being done, and in reading, when the code of the group's number is received on the triggers of the C-MD2. If the code of a group's number read does not coincide with the code on the RA2M, then coincidence does not take place, and the reading of the codes of this group does not occur. In the interval between the end of the skipped group and the beginning of the following control pulse (IK), through the valve V_{31} the TRSpL will again be set in the position of code "1" and on the C-MD2, there will be received the code of the following group's number. In case of noncoincidence of codes, the seeking out of the code of a group's number indicated on the RA2M, will continue. When, however, the code of the number of a group read corresponds with the code on the RA2M, the coincidence circuit gives out a high potential onto the valve V_{27} . The pulse I7 sets the trigger TRSpL in the position of code "0", and at the same time through the valve V_{28} puts the TRSpB, the trigger for solving the coincidence of the drum, into the position of code "1".

From this moment, the circuit of control of the MMD for the drum and

tapes works in identical fashion.

TUpr1, the control trigger No. 1, is used only in working with tapes for cutting in and disconnecting the output of the generator of synchronizing pulses. Synchronizing pulses are fed continuously onto the input of the valve, V_{75} . In the solution of the operation of exchange of codes of the MZUL with the IMD, the valve V_{75} by a high potential "1" of the TRSpL will be opened for potential input. However, the first synchronizing pulse proceeding through V_{75} will set the control trigger No. 1 in the position of code "1". The potential "1" of the TRpr1 controls the valve V_{14} , through which the synchronizing pulses of the tape pass. Control of the coupling in of a generator of synchronizing pulses is necessary in order to have the first pulse from the generator emitted dependably. Besides the use indicated, the TUpr1 is used in the circuit for controlling the control pulses which proceed from the generator of control pulses (GCP) through the valves V_{73} and V_{72} .*

TRSpB (CST), the trigger for solving coincidence on the drum, when recourse is had to the drum, is set in the position of code "1" by a pulse of the RSp of the MMD, through the multivibrator M_2 and the valve V_{30} , opened by the high potential of the drum (TD). From this moment, the control circuit of the MMD is connected up for the operation of exchange of codes between the MMD and IMD.

When recourse is had to the magnetic tape the TRSpB (CST) is used for fixing the code of the group's number. In recording on the tape, the

* The operation of this unit is described in more detail below, in chapter V.5.

TRSpB is set in position "1" by pulse I7 through the valve V₂₆, i.e., when the group's number has already been recorded on the magnetic tape; in reading, however, the pulse goes through the V₂₇ valve when the group number read has coincided with the code on the RA2M and the CC has emitted a high potential.

As in having recourse to the drum, so also when the tape is used, the TRSpB is in the position of code "1" to the finish of the operation, and is set in the position of code "0" by the pulse U "0" of the MMD.

CT, the coincidence trigger, fixes the moments of the beginning and end of the direct exchange of codes between the MMD and the IMD. Onto the input of the V₂₃ valve there pass continuously synchronizing pulses, retarded by 2.5 μ sec.

In having recourse to the magnetic drum the trigger TRSpB, by the coincidence resolving pulse of the MMD is set in the position of code "1". The trigger for fixing the 40th pulses (TI40) is in the position of code "1" between the 40th synchronizing pulse and the 1st synchronizing pulse of the following code. Control in accordance with the potential input of the valve V₂₃ is accomplished from the triggers TI40 and TRSpB. Consequently V₂₃ will let pulse t₁ pass through after the passing through of the code. This pulse passes through the valve V₂₄ and sets the coincidence trigger in the position of code "1" only in case of coincidence of the codes on the register of the second address of the MMD and the computers C-MD2 and C-MD3.

The V₂₄ valve controls the potential from the output of the coincidence circuit. In shifting the coincidence trigger from the position of

code "0" into the position of code "1", the potential gradient is differentiated and a pulse is formed, which, through the valve V_{46} , sets the trigger of the register of the second address in the position of code "0". This same pulse passes through the valve V_{36} and retardation Zv_{14} (Ae_{14}), being retarded (delayed) by $2\mu\text{sec}$, and amplified by the shaper F_2 (S_2) into the central control of the operations of the BESM as pulse TC-2 (receipt of the second address) causing the giving out to the code bars of address (CBA) the code of the second address of the memory command unit (A2MCU).

On the register of the second address of the MMD there is received the code of the number of the track and the code of the number of the place on the drum where the operation is to be finished. This same pulse of the PA2, retarded by $2\mu\text{sec}$ on the Zv_{15} (Ae_{15}), after receipt of the code on the register, will set the trigger for control of the second address (TS2A) in the position of code "0".

When recourse is had to the magnetic tape after recording and reading of the code of the group's number, the pulse I7, through the valve V_{21} and further through the valve V_{26} in recording (or V_{27} in reading), sets the trigger for solving the coincidence of the drum (TRSpB) in the "1" position of the code. Consequently, the following 40th synchronizing pulse, retarded by the time t_1 , passes through the valves V_{23} and V_{25} and sets the coincidence trigger (CT) in the "1" position of the code.

Otherwise, the work of the control circuit in the tape operation is distinguished from the work with the magnetic drum only by the fact that with the pulse of the TC-2 (receipt of the second address), there will be

received on the register of the second address of the MMD, not the address of the place of finishing the code, but the number of the codes in the group, which it is necessary to record on the magnetic tape, or to read from the magnetic or perforated tape (during lead-in).

The control of the transmission of command pulse from the MMD is accomplished by the high potential "1" of the CT in reading, on the valve V_{39} and in recording, on the valve V_{40} .

The emission of pulses of shift onto the BZ2Ch of the BESM during the operation of exchange of codes of the MMD with the IMD is accomplished through the valve V_{45} .

In the process of the operation of the exchange of codes, onto the computers C-MD2 and C-MD3 (the latter functions as if it were a continuation of the C-MD2) in recording or reading one code, + "1" is impressed. When the codes on the register of the second address, end of place on the drum or number of codes in the group on tapes and on computers C-MD2 and C-MD3 coincide, the coincidence circuit will emit a high potential, which opens the V_{24} valve.

The synchronizing pulse, retarded by the time t_1 , passes through the valves V_{23} and V_{24} onto the computing input of the coincidence trigger, which is shifted from the position of code "1" into the position of code "0". The voltage gradient meanwhile is differentiated and is amplified on the valve V_{48} , and through the valves V_{54} and V_{47} there is accomplished the setting in the position of code "0" of all the triggers of the MMD cells.

When the drum trigger (TD) or the tape trigger (TT) is set in the

position of the code "0", the voltage gradient is differentiated, and the shaped pulse directly, or through the multivibrator (used as an electron retarder) and the shaper S_3 , is given out to the BESM as a pulse of completion of the operation from the MMD (PCO), which sets off the control of the BESM. The retarding of the PCO, after the finish of recourse to the tape, is necessary so that after coupling the computers C-SPl and C-MD2 to the work with the magnetic drum, the beginning of the reading of the synchronizing pulses will be fixed correctly.

The beginning of the reading SP is controlled by the single pulse of zero setting of the drum (U"O"MB) (S"O"MD) during each turn of the drum.

After having recourse to the tape, the next command may be recourse to the drum. Therefore, the time of retardation of the PCO should be not less than 80 milliseconds (time of one turn of the drum).

The triggers of the drum, of the tape, and of the recording and reading, show to which device recourse is to be had, and also the character of the operation (recording or reading). The potential of these triggers is used for the control of the corresponding circuits of the MMD.

TRew, the rewinding trigger, controls the circuits which accomplish the rewinding of the tape to the number of the group indicated in the command*.

CoT2, control trigger No. 2, is intended for the control of the synchronizing pulses in reading from the magnetic tape, for setting the C-SPl in the position of code "0" in the absence of the synchronizing

* For the operation of the rewinding unit, see Chap. V, 7.

pulses, and for setting the TRSPL in the position of code "1" in reading the group* while passing.

DT, the drive trigger, controls the turning on of the voltage to the clutch of the forward or backward movement of the selected magnetic tape recorder.

RPT, the recording pulse trigger, is used for recording the code on the magnetic drum as a shaper of the pulses of fixed length.

NT, the number trigger, serves for recording the binary code on the drum and reading the code from the magnetic or perforated tape.

In recording the code on the drum, valve V_{81} is opened by the high potential of the coincidence circuit of the controlling triggers for the drum, the recording, and the coincidence.

The synchronizing pulses corresponding to the places at which the code should be recorded during the time t_1 , set the trigger of the recording pulses in the position of code "1". During the time t_4 , these same synchronizing pulses set the trigger in the position of code "0". In this way (from the output of the trigger of the recording pulses), there issues a jump in voltage of $7.5 \mu\text{sec}$ in length. This jump in voltage, or as we call it, recording pulse, is fed to the cathodes of the diodes D_2 and D_3 of the two coincidence circuits. One of them is designed on the diodes D_1 and D_2 and the resistance R_1 . Depending on the condition of the number trigger, the output potentials of which control the diodes D_1 and D_4 , on the output of one of the coincidence circuits a jump in voltage will be

* For the operation of the TUpr2 (CoT2) see Chap. VI, 3.

given out, i.e., the recording pulse. The recording pulse is amplified by the cathode repeater of the type Cb and is passed to the corresponding circuit of code recording.

The position of the number trigger is determined by the code to be recorded. In the case of code "1", which goes to the circuit "code to MMD", a pulse goes simultaneously with the synchronizing pulse of the drum, through valve V_{79} and it sets the number trigger in the position of code

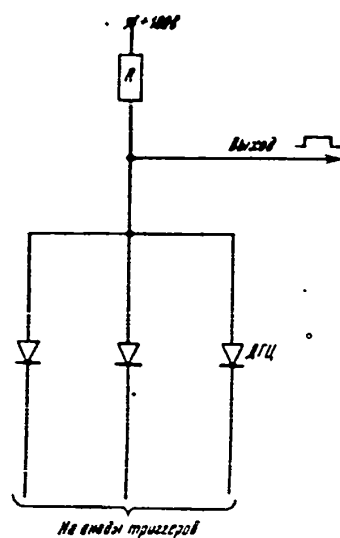


Fig. 42. Diode Circuit of Coincidence of Potentials

"1". The corresponding synchronizing pulse, retarded by the time $t_8 = 20$ sec, sets the number trigger in the position of code "0". In recording code "0", in the circuit "code to MMD" a pulse is absent and the number trigger remains in the position of code "0". At the moment of time $t_1 - t_4$, a high potential comes from the trigger of recording pulses, and the coincidence circuit emits a recording pulse into the recording circuit of code "0".

During reading from the tape, the valve V_{79} is closed by the low potential "1" of the recording trigger. The code to be read passes onto the input of the open valve V_{78} . During code "1" a pulse proceeds through V_{78} and sets the number trigger in the position of code "1". A high potential from the number trigger controls valve V_{64} , onto the input of which the synchronizing pulses pass, retarded by the time t_7 . Consequently, the

code "1" being read is transmitted through V_{64} and V_{63} into the general circuit which sends the code from the MMD. The same synchronizing pulses in the time t_8 , through valve V_{77} , return the number trigger to the position of the code "0". In reading code "0", the pulse is absent on the input of the valve V_{78} , and the number trigger remains in the position of code "0". The valve V_{64} is closed by the low potential and a pulse does not enter the circuit which issues the code.

For the purpose of controlling and emitting fixed consecutive pulses during the operation of exchange of codes of the IMD or the DMD with the MZU, the circuit for forming command pulses is used, which consists of consecutively connected amplifiers with retardation of the type Ae and valves.

From the shaper $F_1 (S_1)$, the synchronizing pulses proceed to the circuit of the retardation (delay) units $Ae_1 - Ae_8$, of which each one delays a pulse by 2.5 sec. In this way, the command pulses are formed.

The pulses $t_1 - t_8$ in passing through the corresponding controlled valves onto the circuit of the delay units $Ae_9 - Ae_{13}$ are used in the exchange of codes for emitting the time patterns into the circuits of control of the BESM and the IMD, and also for control of the corresponding circuits of the MMD.

In the control circuits of the MMD, connecting circuits of several controlling potentials are used. By definition, these circuits are circuits of potentials' coincidence. All of them are designed on germanium diodes of type DGTs and resistors. An example of such a circuit is shown in Fig. 42. On the output of the circuit there will be a high potential of +100 v

only in the case where all three control triggers are in the position of code "1" and the potentials of the cathodes of all the DGTs are equal to the potential on the anodes.

It is sufficient that one of the triggers be in the position of code "0", for the corresponding diode DGTs to bypass the circuit for passing the current. As a result, current flows through the resistor R and, owing to a drop in the voltage on the resistor, we get a low potential on the circuit's output.

CHAPTER V

Operation of the MMD

1. PREPARING THE OPERATIONS WITH THE MMD

The control of the exchange of codes with the internal memory device of the BESM is effected by the control circuit of the magnetic memory device (see Fig. 41).

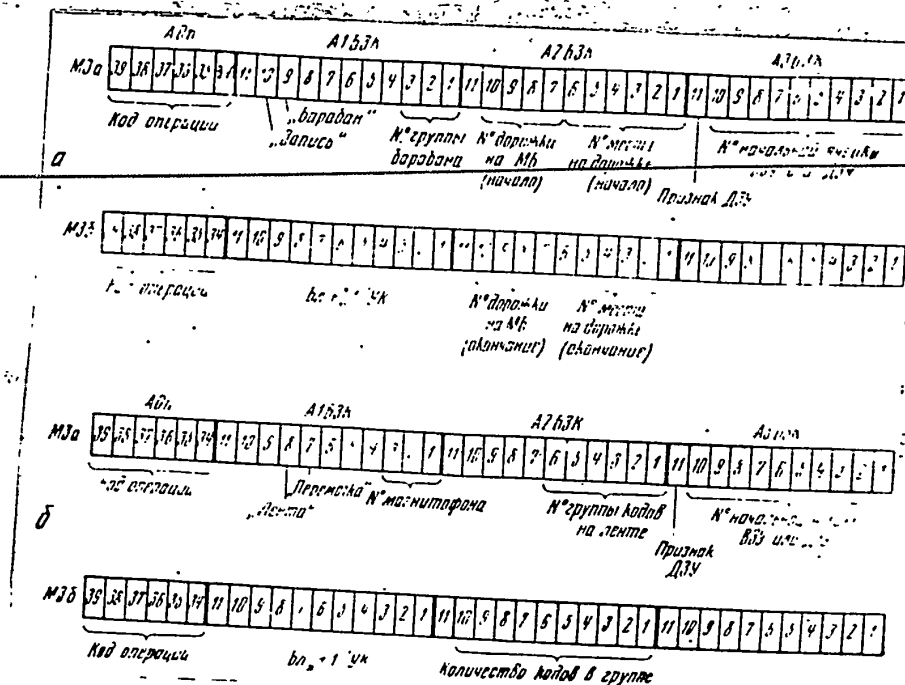


Fig. 43. Codes of the Commands of the CR and the GPS (Arrangement of the Codes of the Commands in the Memory Unit):

- with recourse to the magnetic drum
- with recourse to the magnetic tape

From the central control of the BESM, there originates only the preparation of the operation with the MMD. For this circuit, only two commands are evolved, CR and CPS: during exchange with the drum (Fig. 43a) and exchange with the tape (Fig. 43b).

The command CR consists of:

- a. code of operation, CR (10110);
 - b. code of the address A1, code of the nature of the operation: "recording" of "reading" and "drum" or "tape" (forward movement or re-winding), and also the code of the group's number on the drum or the number of the tape;
 - c. code of the address A2, code of the number of the figure and the track on the drum from which the recording or reading should be begun, or the code of the group's number which is to be read or recorded on the tape;
 - d. code of the address A3, code of the number of the place in the IMD from which the exchange should be begun. If the recording is done on the MMD from the DMD, then in the A3 there will be indicated the number of the first figure to be recorded on the DMD.
- In recording from the DMD in the A3, there is also indicated the 11th discharge, the sign of having recourse to the DMD. The command CR is accomplished in the following sequence (see Fig. 44, diagram of execution of the commands CR and CPS):
- a. the zero setting (S*O*MMD) is effected by the I24 (pulse 24) of the preceding cycle;
 - b. from the CCOp of the BESM at the moment of the pulse I2TsU in the MMD, a gate pulse of the RAlM is emitted, which opens the input valves

of the RALM;

c. in $0.3 \mu\text{sec}$ after the gate pulse, there is emitted the pulse of transmission of command (RC), by which the code is transmitted from A1MCU to RALM by the CBA (code bars of the address);

d. from the CCOp by the pulse I2CC, delayed by $1 \mu\text{sec}$, the pulse S "1" is emitted by the TS2A and the input valves of the RA2M are opened;

e. by the pulse I7, the code is transmitted from the cells of the A2MCU through the CBA onto the RA2M (circuit of the TC-2); if the operation of the exchange of codes with the drum takes place, the code of the address from the cells of the A2MCU is issued to the cells of the RA2M (1st--10th discharge), and simultaneously the code is given out to the corresponding cells of the tracks counter, C-MD3; during the operation of transmission of the code to the tape, the code from the cells of the A2MCU (number of the group) is fed only to the 1st--6th step of the RA2M in the case of the reading operation; during recording the code of the group's number is received simultaneously with the 1st to the 6th step of the RA2M, also on the corresponding cells of the C-MD2;

f. at the moment of the pulse I10TsU the trigger TS2A is set in the position "0", and the input valves of the RA2M are closed;

g. the code of the address of the first number on the IMD or DMD, which is in the A3MCU is transmitted to the LCC if the computation is being done on the CCC, or to the CCC if the computation is being done on

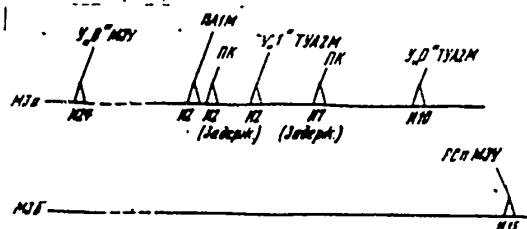


Fig. 44. Time Diagram of Sequence of Execution of the Commands CR and CPS.

the LCC (circuit of the TC-3). In the cells of the CCC unit (if the computation has been done on the CCC), the code of the command's number is remembered, from which the execution of the program will be continued after exchange of codes of the MMD with the IMD or the DMD.

With this the preparation of recourse to the MMD is finished. The command CR to the MUC is eliminated and the following command is selected, the CPS (see Fig. 43). The receipt of the CPS command takes place through the RC circuit.

The CPS command consists of:

- a. code of the operation, CPS (010111);
- b. code of the address A1, zero code; if on checking the MMD, it proves necessary to record one and the same code in the 6th step of the address A1, the code "1" is set up; in this case in the control of the BESM (CCOp) blocking of the circuit +*1" of the CoC takes place;
- c. code of the address A2, code of the number of the figure and code of the track on the drum on which the recording or reading should be ended, or the number of the codes which should be recorded or read from the tape;
- d. code of the address A3, zero code.

During the CPS command, the control of the BESM (CCOp) (at the moment of the pulse 115TsU) stops the central control of the BESM and sends to the MMD a starting pulse of SC MMD. From this moment, the control of the BESM is transmitted to the MMD, and the operation of codes' exchange begins directly.

The following variations of the operation of exchange with the MMD are possible:

transmission of the code from the IMD (or DMD) to the MMDD (recording on the drum);

transmission of the code from the MMDD to the IMD (reading from the drum);

transmission of the code from the IMD (or DMD) to the MMDT (recording on the tape);

transmission of the code from the MMDT to the IMD (reading from the tape);

introduction of the code from the PL to the IMD (work of the device of input on the circuit of automation of the MMDT).

2. INITIAL POSITION BEFORE RECOURSE TO MEMORY DEVICE

Before recourse to the MMD is had, all the control triggers of the MMD are in the position "0" with the sole exception of the triggers of the CSP, the C-MD2 and the TI40. Synchronizing pulses from the magnetic drum (SP MD) pass from the output of the reading amplifier (AP-SP-MD) through the valve V_1 and shaper S_1 onto the input of the CSP, onto the input "0" of the TI40, and onto the input of the delay filter, which forms the time-shifted pulses, t_1-t_8 . From the output of the C40 each 40th SP is directed to the input "1" of the TI40, and through the valve V_{17} or V_{20} onto the input of the C-MD2, which in this system is coupled in accordance with the circuit of the binary counter. The C-SP1 and C-MD2 compute the pulses SP which proceed from the AP-MD. On the path of the SP, 40×64 pulses are recorded. Therefore, after each turn of the drum, the counters CSP and C-MD2 find themselves in the position of code "0".

To eliminate the possibility of the counters' getting out of the system of correct counting (occasional deviations after coupling the power or switching over the counters from the tape to the drum) there is provided a special circuit for confirming their position after each turn of the drum. Synchronizing pulses are recorded on a path around the circumference of the drum. Between the first SP and the last, the 2560th, there is an interval equal to about one tenth of the circumference of the drum. On the second synchronizing path of the MD in this interval, there is recorded the pulse for zero setting (S"O"MD). The presence of the interval between the first and the last SP is also necessary for damping the commutation circuits during automatic transition from track to track when working with the MMDD.

The pulse S"O"MD is read through the amplifier-AP S "O", passes through the valve V_{13} onto the inputs S"O" C-SP1 and C-MD2 and sets them in the position of code "0" (if the counters have not deviated, it simply confirms their position).

In this way, on the CSP and C-MD2 at each moment of time, there is a code reflecting the angular position of the drum, and the trigger TI40 by each 40th SP is set in position "1" and is returned to position "0" by the following SP.

The remaining triggers, as shown above, when recourse is not being had to MMD, are in position "0", where (to eliminate the probability of occasional deviation) this position for every cycle of CC is confirmed by the pulse S"O"MMD coming from the CCOp of the BESM onto V_{55} .

3. RECORDING CODES ON THE MAGNETIC DRUM

The operation of recording of the MD begins from the moment of receiving on the MUC of the BESM the commands CR with the presence in its first address of the 10th step (recording) and 9th discharge (drum). The command CR constitutes a preparatory command for the MMD and performs the following elementary operations:

a. at the moment of the pulse I2CC from the CCOp, out of the BESM into the MMD, there is issued a gate pulse RAlM, which opens the input valves of the control triggers, TD, TT, RT, Trew and register of the CM2; in 0.3 μ sec after the RAlM, the pulse I2CCOp gives out a code onto the CBA from the AlMCU; pulses of the code coming over the CBA9 and CBA10 place in position "1" the triggers TD and RT; the pulses of the code from CBA1—CBA3 set the triggers of register of the CM2; one of its outputs selects the number of the group of the MD on which the recording will be done; the CM2 opens the valves of recording and reading on the corresponding group of the CIOU;

b. at the moment of the pulse I2CC, delayed by 1 μ sec from the CCOp there is issued the pulse S "1" by the TS2A; the trigger TS2A, through the valve V₃₈ is set in position "1" and opens the input valves of the RA2M and the C-MD3; the pulse I7CC feeds a code onto the CBA from the A2MCU, i.e., the address code by which the first number is to be recorded on the MD; this code is received on the RA2M and on the C-MD3 (number of the track on which the first number is to be recorded); at the moment of the pulse I10CC from the CCOp, there passes into the MMD the pulse S "0" of the TS2A, and the input valves of the RA2 and C-MD3 opened.

c. the address code of the first number on the IMD from the A3MCU is transmitted to the LCC (if the counting is being done on the CCC) or to the CCC (if the computation is being done on the LCC).

With this, the preparation of recourse to the MD is ended. The command CR to the MUC is extinguished, and the following command is selected, the CPS. The command CPS constitutes an executing command and effects the starting of the control circuit of the MD. In the A2MCU on the command CPS, there is an address code, in accordance with which the last figure is to be recorded on the MD.

On the command CPS of the CCOp at the moment of the pulse IL5CC, the central control of the BESM stops and transmits to the MMD the starting pulse of the SC MMD. From this moment, the control of the BESM is transferred to the MMD and the operation of recording codes on the MD begins. The pulse of SC MMD passes to the input of the multivibrator M_2 and further through the valve V_{30} , which is controlled by the potential from the drum trigger (TD). It sets the trigger for solving the coincidence of the drum (CST-D) in the position of code "1". Meanwhile, the M_2 multivibrator is used as an electron delay unit for the pulse of the SC. The pulse of the SC is delayed for a time sufficient for the growth of the fronts of the commutator of the tracks, even in those cases where the recording is begun immediately after setting the trigger CST-D in the position of the code "1".

The triggers CST-D and TL40 open valve V_{23} , and each 40th SP, after reaching valve V_{24} , checks the coincidence of the codes on the RA2 and the codes on the C-MD2 and C-MD3. The coincidence of the codes on the C-MD3

and of the 7th to the 10th discharge of the RA2 is insured right from the start, since on both of them there is the code of the number of the tracks of the MD from which the recording is to begin. The coincidence, then, of the 1st to the 6th discharge of the RA2 and the C-MD2 takes place only when the place of the magnetic drum (on which should be written the first figure) comes under the magnetic head of the unit of the CIOU. At this moment, the codes on the C-MD2 and the 1st to the 6th step of RA2 coincide, the coincidence circuit gives out at its output a high potential and opens the valve V_{24} . The corresponding 40th SP passing through valves V_{23} and V_{24} sets the trigger CT in position "1". In its passing from position "0" into position "1", the jump on its output "1" is differentiated and amplified by the valves V_{36} and V_{46} . The pulse from the output of V_{46} extinguishes on the RA2 the no longer needed code of the address of the first figure. The pulse from the output of the valve V_{36} puts the trigger TS2 in position "1", this trigger opening the input valves of the RA2. The input valves of the C-MD3 are not opened this time, since the controlling potential circuit (see Fig. 36) is blocked by the low potential "0" of the CT. Besides, the pulse from the valve V_{36} in passing through the delay unit ($3 \mu \text{ sec}$) and the shaper S_2 is fed to the CCOp of the BESM as a pulse of the TC-2 and produces the emission to the CBA of the code from the AZMCU, i.e., the code of the address, in accordance with which the last figure is to be recorded on the MD, and, finally, the same pulse, delayed by $2 \mu \text{ sec}$ puts the trigger TS2A in the "0" position, thus closing the input valves of the RA2M.

The coincidence trigger CT is set in the position of code "1" by the

40th SP at the moment t_1 . This same 40th SP, delayed by the time, t_3 , passes through the valve V_{40} opened by the high control potential ("1" RT + "1" CT + "1" TI40) onto the control unit for exchange of codes. From the output of the shaper S_4 , the pulse is issued for the "0" setting of the registers of the IMD, DMD, and TCMD. After $12.5 \mu\text{sec}$, this same pulse going through the delay circuit of type 3v, valve V_{43} and shaper S_6 emits a pulse of transmission of address code from the LCC (or CCC) the TCA, the pulse + "1", LCC (or CCC) which prepares the address of the following number of the SC of IMD and DMD. The pulse of the SC starts the corresponding operative memory device, and after $10 \mu\text{sec}$ (at the operating frequency of the BESM, 400 kcps) issues to the BZ2Ch of the arithmetical device (AU BESM) the code of the first figure which is to be recorded on the MD. For a shift register of codes in the exchange with the MD, the memory unit of the second number of the BZ2Ch and the memory unit of the order of the first number of the BZ1P of the arithmetical device are used. The shift is effected towards the lower steps.

Strictly, the recording begins with the receipt of the SP following the 40th SP which produced coincidence, i.e., from the first SP.

This SP, in passing through the valve V_{45} and the shaper S_8 into the CCOp of the BESM, produces a shift of the code which is on the BZ2Ch and BZ1P of the AU by one step in the direction of the lower step. During this, if in the first step of the BZ2Ch, there is the code "1", then the code pulse comes into the MD by the circuit "code to MD". This pulse sets the trigger NT in the position "1" through the valves V_{85} and V_{79} . At the moment t_1 , the same 1st SP puts the trigger RFT in the position "1",

and after $7.5 \mu \text{sec}$, at the moment t_4 , returns this trigger to the "0" position.

As a result, on the output of the diode circuit of pulse shaping of the recording "1", there arises the pulse of recording "1", which is amplified in power by the cathode repeater and is transmitted to the inputs of the recording valves of "1" or the CIOU.

If in the first step of the BZ2Ch there is code "0" before the shift, then the shift does not produce the appearance of the code pulse in the circuit "code to MMD" and the trigger NT remains in the "0" position. In this case, the pulse is sent to the inputs of the valve for recording "0" of the CIOU and on the track selected, the first step of the first figure is recorded.

The 40th pulse SP, in passing the valve V_{23} in the moment of time t_1 , goes to the valve V_{24} and checks the coincidence of the codes on the RA2 with the codes on the counters C-MD2 and C-MD3.

If there is no coincidence, then the 40th SP in the moment of time t_3 arrives at the unit controlling the exchange of codes, as was described above, gives out controlling pulses which produce the codes of the following number from the memory device on the B32Ch and BZ1P. Each 40th SP adds "1" to the code on the C-MD2. In the transition of the C-MD2 from the code "63" to the code "0" through the valve V_{34} controlled from the potential "1" of the trigger CT, "1" is added to the code of the number of the track, which is on the C-MD3, and the recording passes over to the following track. The recording continues until the moment of coincidence of the code on the RA2 with the code of the C-MD2 and C-MD3.

When the codes coincide, the valve V_{24} is opened by the high potential of the CC, and the 40th SP passing to the input of the trigger CT, changes it to the "0" position. The differentiated jump from the output "0" of the CT is amplified by the valve V_{48} and is transmitted to the circuit S "0" of the MMD producing the setting of all the control triggers of the MMD in the "0" position, i.e., it stops the recording operation on the magnetic drum.

At the moment of shifting the drum trigger from the position of code "1" into the position of code "0", the jump in the potential is differentiated and is fed to the input of the multivibrator M_5 . From its output to the input of the shaper S_3 , there passes an amplified pulse sufficiently delayed in time for damping the commutation circuits of the paths of the MD (here we mean the case where, after the finish of one turn, another immediately follows).

From the output of the shaper S_3 , the pulse for completing the operation (PCO) is transmitted to the circuit for starting the CC of the BESM and the control of the BESM again passes to the CC.

4. READING CODES FROM THE MAGNETIC DRUM

The work of the circuit of the MMD during the reading of the codes from the magnetic drum to a considerable degree is analogous to the work of recording on the MD. The difference consists only in the work of the unit controlling the exchange of codes, which in this case should not emit codes from the memory device, but on the contrary should record them in the internal memory device. The difference is also that instead of the unit

for recording codes (NT, RPT and the diode circuit of coincidence of the IZp "1" and the IZp "0"), the unit of reading codes from the MD is working. The operation, "reading from the MD" begins from the receipt on the MUC of the BESM of the preparatory command of the CR. However, in the operation "reading from the MD" in the command of the CR, the code "1" in the 10th step of the ALMCU drops out.

The operation of the control circuit of the MD in reading and recording up to the moment of the first coincidence is completely identical. The 40th pulse, which puts the trigger CT in position "1", does not emit any pulses to the CCOp; hence, during the "reading" operation, the synchronizing pulses pass to the unit controlling the exchange of codes through the valve V₃₉ in the moment of time t_1 , i.e., to the setting of CT in the position "1". Change in the condition of CT is accomplished by the pulse t_1 , additionally delayed by $0.8 \mu \text{ sec}$. The extinguishing of the code on the RA2 and the receipt on it of the code from the AZMCU takes place during reading just as during recording.

The circuit for shaping the pulses IZp "1" and the IZp "0" in reading does not operate since the valves V₇₉ and V₈₁ on the inputs of the triggers NT and RPT are closed by a low potential. The code to be read from the selected group of the MD passes from one of the valves V₆₅—V₆₉ through the valve V₆₂ opened by a high potential "0" of the RT (sign of reading), the valve V₆₁, and the shaper S₉ into the AU of the BESM. The synchronizing pulses, just as in recording, pass through the valve V₄₅ and the shaper S₈ in the CCOp of the BESM into the circuit for shifting the code on the triggers BZ2Ch and BZ1P. In this way on the BZ2Ch and the

BZ1P there is produced a conversion of the code to be read from the consecutive to the parallel. After the receipt of the 39th SP on the triggers of the BZ2Ch and BZ1P there is the code of the first number. The 40th SP does not go onto the "shift": it is blocked on the valve V_{45} . This code should be sent for remembering into the internal memory device. In view of the fact that provision is not made in the AU for the direct emission of the code from the BZ1P onto the input bars, it is necessary before recording on the IMD to transmit the code onto the summator of the order (SmP). The 40th SP passing in the moment of time t_1 through the valve V_{38} of the control unit of the exchange of codes emits this same sequence of pulses just as in recording. Besides, by the pulse, delayed relative to time t_1 an additional 2.5μ sec, there is sent through the valve V_{44} and the shaper S_7 the signal "+Ch" (transmission of code from BZ1P to SmP). In reading simultaneously from SC IMD, there is further given out a pulse RoIMD (pulse of recording on the IMD) and a pulse of EN to IMD, producing the emission of a code from BZ2Ch and SmP to CB. The code is remembered by the internal memory device, and on the BZ2Ch and BZ1P there begins the reading of the code of the following number. The completion of the operation in reading from the MD is accomplished exactly as in the case of recording on the MD. Since the emission of control pulses in reading begins at the moment t_1 and the coincidence is checked at the moment t_1 , delayed by 0.8μ sec, the last code read gets into the internal memory device.

5. RECORDING OF CODES ON THE MAGNETIC TAPE

The operation "recording on the MT" is begun from the moment of receipt on the MUC of the preparatory command CR if in the first address of this command there is the code "1", in the 8th step (sign "tape"), and in the 10th step (sign "recording").

On the command CR on the MT, the following elementary operation is accomplished.

a. From the CCOp of the BESM at the moment of the pulse IzTsU there is given out the pulse RAlM, which opens the input valves of the triggers TD, TI, and RT and the CM2 register. After $0.3 \mu\text{sec}$, the CCOp emits the code of the address with the ALMCU. The pulses of the code coming over the CBA8 and CBA10, set triggers TT and RT in the position "1". The pulses of the code on the CBA1--CBA3 are set on the register of the CM2, the code of the number of the magnetic tape recorder on which the recording is to take place. The trigger RT effects the commutation of the control circuits of the MD for the recording. The trigger TT, set in position "1", opens the C-SP1, and, consequently, the C-MD2 from the SP of the MD (opening valve V_1) and couples them into the circuit of the SP of the MT (opening valve V_2). However, the SP of the MT is not fed to the computer since the valve V_4 is closed by the trigger of control of the SP of the tape (CoTT), which finds itself in the "0" position. At the same time, there is disconnected from the C-SP1 and C-MD2 the pulse S "0" from the path of the pulse of the beginning of the reading (the valve V_{13} is closed). The commutator CM2 prepares the coupling-in of the relay of the clutches of the given magnetic tape recorder.

b. Out of the CCOp at the moment of the pulse I2, delayed by $1\mu\text{sec}$, there is issued the pulse S "1" of the TS2A. This pulse passes through valve V_{14} into circuits "0" of the C-SF1 and C-MD2 and sets them in "0" position. Besides, passing on to the input "1" of the TS2A, it opens the input valves of the RA2 and the C-MD2. The pulse I7CC delivers to the CBA the code of the group's number which is to be recorded on the MT. At the moment of the pulse I10CC from the CCOp into the MMD, there passes S "0" of the TS2A, and the input valves of the RA2 and the C-MD2 are opened.

c. Afterwards, just as when using the MD, there is transmitted from the A3MCU onto the LCC or CCC the address code of the first number in the internal memory device.

With this, the preparation of recourse to the MT is finished. The command to the MUC is cancelled, and from the internal memory device there is selected the following command, i.e., the supplementary command CPS. In the A2 of the command CPS there is the code of the count of numbers which is to be recorded on the tape.

On the command CPS, the pulse I15CC stops the central control of the BESM and transmits to the MMD the starting pulse of the SC MMD. From this moment, the control of the BESM passes over to the MMD, and the operation of recording the codes on the MT begins directly.

The pulse of the SC MMD, having passed through the valve V_{76} , will set the drive trigger (DT) in position "1". Meanwhile, the relay of the drive RP (see Fig. 29) will feed (through the normally closed contact of the relay of the direction of the turning [RNP], and further through the control relay) voltage from the CM2 onto the winding of the relay for

coupling the clutches of forward movement of the magnetic tape recorder.

The selected CM2 of the relay is shifted and connects the clutch of the forward movement of the given magnetic tape recorder, and the magnetic tape begins to move.

Through the multivibrator M_3 which delays the SC MMD pulse sufficiently for the recorder to get started, the trigger CST-Ta is set in position "1". The latter closes the computation valves V_{20} for the C-MD2 and opens the shift valves. Besides, the trigger CST-Ta opens valve V_{75} . Meanwhile, the SP nearest in time passing from the originating generator through the valve V_{75} puts the control trigger CoTT into position "1". The trigger CoTT opens valve V_4 , and during the following pulse SP passes to the C-SP1, and also to other circuits of control of the MMD, and the process of recording the codes on the ML begins at once.

Through the valve V_3 , synchronizing pulses pass to the unit CIOU-t for recording on the synchronizing path. At the same time, the SP passes through valves V_{84} and V_{82} into the channel of the recording of the CIOU-t code, while valve V_{84} is opened by the potential from the output "1" of the trigger T_1 of the C-MD2 and from the output "1" of the CST-Ta.

The code which is on the C-MD2 is shifted by each SP in the moment of time t_6 by one step in the direction from T_6 of the C-MD2 to T_1 of the C-MD2. The SP passes into the shift circuit of the C-MD2 through valve V_{29} , controlled from the potential "1" of the trigger CST-Ta. In this way, each SP records on the magnetic tape the corresponding step of the code of the group's number. The code of the group's number consists of six binary steps; therefore, after the 6th SP, it is completely recorded on the tape.

The pulse I7C-SP1 (7th SP), having passed through valves V_{21} and V_{22} , sets the trigger CST-Ta in position "0", and the CST-D through valves V_{26} and V_{28} in position "1". The low control potential of the trigger CST-Ta meanwhile closes the shift valves of the C-MD2 and opens the valve of computation. Besides, valve V_{84} is closed in the channel of the recording of the group number code.

The trigger CST-D being in position "1", opens valve V_{83} , thus preparing the circuit for the emission of the pulse of the code being shifted on the arithmetical device into the channel of recording of the CIOU-t code.

From the moment of receipt of the pulse I7, the work of the circuit in recording on the MT completely coincides with its work in recording on the MD, with the exception that here the trigger CT is placed in position "1" by the first 40th SP (without dependence on the coincidence of the codes on the RA2 and C-MD2. This is insured by the fact that valve V_{24} , controlled by the potential of the control circuit, is shunted when working with the MT, by valve V_{25} , controlled by the potential from "1" TT + "0" CT. Another difference is to be found in the feed of the pulses into the CIOU-t unit. In recording on the magnetic tape, the MT and RPT unit does not function. The SP is fed to the CIOU-t through valve V_3 , and the code pulse through valve V_{82} . With the coincidence of the codes on the C-MD2 and the C-MD3 with the code on the RA2, as in recording on the MD, a pulse is formed which sets all the triggers of the control of the MD in the "0" position. The counters C-SP1 and C-MD3 are coupled to the SF of the MD. However, the code on them does not correspond to the angular position

of the MD, since the counters are coupled in on the SP of the MD at an arbitrary moment. Therefore, in the circuit of the PCO of the MMD, the multivibrator M_6 is provided with delay time equal to the time of one turn of the drum. By the moment of starting the CC, there must pass from the track of the beginning of reading, the pulse S "0" MD, which establishes the correct position of the counters.

6. READING CODES FROM MAGNETIC TAPE

The work of the control circuit of the MMD in the operation of reading from the MT is to a considerable degree analogous to its work in the operation of recording on the MT.

The differences consist in the following:

- a. On the command CR, the trigger RT is not put in position "1".
- b. The trigger TS2A does not open the input valves of the C-MD2, and the code of the group number is received only on the RA2.
- c. The trigger CST-Ta is set by a pulse of the SC of the MMD, not through the multivibrator M_3 , but through the multivibrator M_4 , which has less time delay, so that the work of the control circuit will be begun by the moment when the group to be read comes up to the magnetic head.
- d. The trigger CoTT, as in recording, is put in the "1" position by pulses from the master generator, although onto the computers and the control circuit, the synchronizing pulses are not fed from the generator, but from the unit CIOU-t (valve V_7 is open and valve V_8 is closed).
- e. Code recording pulses are not fed to the CIOU-t (valves V_{82} and V_3 are closed).

f. The pulses of the code from the CIOU-t (read from the MT) are fed through valve V_7 onto the trigger T_6 of the computer C-MD2 (see Fig. 39). The shift on the C-MD2, as in recording, proceeds from each SP in the moment of time t_6 . As a result, after the 6th SP, the group number code is on the C-MD2, read from the magnetic tape.

g. As in recording, the 7th SP puts the trigger CST-Ta in the position "0", couples over the C-MD2 from the register circuit with shift onto the circuit of the counter and stops the feed onto the C-MD2 of pulses of shift (closes valve V_{29}). However, the trigger CST-D is put during reading into the position "1" by the 7th SP only in the case where the codes on the counter C-MD2 and the register RA2 coincide, i.e., just that group which is to be read passes over the magnetic head. If the codes do not coincide, then valve V_{27} is opened by the low potential of the CC (valve V_{26} is also shut during reading), and the setting of the trigger CST-D in position "1" does not take place. In this case, the group will be let through with the reading of the codes. After the finish of the group, when the SP ceases to pass from the CIOU-t, the trigger CoT is placed by control pulses in position "1", and these pulses, having passed through valves V_{70} and V_{31} , again set trigger CST-Ta in position "1". Again on the C-MD2, there is read the number of the following group and by the 7th SP its coincidence with the given number is checked. If the codes on the C-MD2 and the RA2 coincide, then pulse I7 proceeds through valves V_{27} and V_{28} , sets the trigger CST-D in position "1", and at the same time extinguishes the code on the C-MD2. From this moment, the control circuit works just as in reading codes from the MD.

h. The channel of the reading of the codes in working with the magnetic tape, however, differs somewhat from the channel of the codes' reading when working with the drum. The code from the CIOU-t passes to the input "1" of the trigger NT (through valve V_{78}). By the potential of the input "1" of the trigger NT, valve V_{64} is controlled; onto its pulse input there proceed the synchronizing pulses in the time t_7 , and valve V_{64} lets through a pulse only with the code "1" on the trigger NT. Further, the code through valves V_{64} and V_{61} and the shaper S_9 proceeds to the AU of the BESM.

i. For reading from the magnetic tape, there is provided a special blocking. If for some reason the reading of the SP from the tape is stopped before the second coincidence takes place, then the control pulse, having passed through valve V_{74} , sets the triggers DT and CoTT in position "0", and the magnetic tape recorder stops. The condition of the code on the other triggers is preserved. Therefore, by the indications of the computers, one can know the number of SP lacking.

7. REWINDING OF MAGNETIC TAPE

The performing of the operation of "rewinding the MT" differs very little from the operation of "reading from the MT". In the A1 on the command CR for rewinding, there is the code "1" in the 7th step. Therefore after the issuing out of the CCOp of the address code from the AlMCU, the trigger Trew (see Fig. 29) is set in position "1" and the RNW (relay of direction of turning) switches over the contact of the drive relay (RP) onto the windings of the relays of the clutches of the reverse movement of

the magnetic tape recorders. As a result, when the pulse of the SC MMD sets the drive trigger (DT) in position "1", the magnetic tape recorder selected by the CM2 begins to turn the tape reel in the reverse direction. Just as in reading, there is produced on the C-MD2 a shift of the code which is coming to the CIOU-t. However, in rewinding the circuit S "0" of the CST-Ta is blocked on the valve V_{21} , and the shift of the codes to the C-MD2 continues during the entire time of the group's passing over the magnetic head. When the group finishes, on the C-MD2 there remains the code of the group's number, but in reverse order (since the reading proceeded from the end of the group to the beginning). Therefore, on the command CR, the code of the group number is passed to the RA2M in reverse order, and for this there are provided special input valves controlled in accordance with circuit "1" of the Trew + "1" of the TS2A + "0" of the TD (Fig. 39).

The control pulse (IK) entering the intervals between the groups, checks on the valve V_{51} coincidence of the codes on the C-MD2 and RA2. In case of coincidence, this valve lets through the pulse, which, having passed through the multivibrator M_7 , goes on to the circuits S "0" of the MMD and the PCO MMD.

The multivibrator M_7 serves for delaying the pulse IK checking the coincidence. The pulse passes onto the input of the M_7 only in the case where after the operation of the multivibrator the coincidence of the codes on the C-MD2 and the RA2 continues, i.e., the circuit will not react on the short coincidence of the codes which can be in the process of reading, and it operates only in the interval between two groups.

The multivibrator M_7 also delays the moment of stopping, which is necessary to create a reserve of length in the tape before the beginning of the group in order to insure that the magnetic tape recorder gets fully started for the following reading. The pulse S "0" M-D sets all triggers of the M-D in the "0" position, and the PCO M-D starts the CC, with which the operation of the "rewinding of the MT" is finished.

CHAPTER VI

Preventive Inspection of the MMD

1. OBJECTIVES IN CHECKING

Uninterrupted working of the BESM as a whole depends on the quality (precision) of the action of its separate units.

A preventive inspection of the MMD device can be carried on by coupling in the connections with the basic device or independently. However, as a rule, the checking of all the internal automation circuits, and also of all the channels of recording and reading, is done independently of the basic device.

After the detection and removal of unreliable elements of the internal circuits, a check is made of the connections with the basic stand. In doing this, special attention is paid to the elements working in the connecting circuits.

In such an inspection one checks:

- all electron circuits;
- the condition of the magnetic layer on the drum;
- the quality of the magnetic tape on which the recording is to be done;
- the serviceability of the recording and reproducing heads;
- the working of the drives of the drum and the tape.

The standard units are checked by methods which are common to all standard units of the BESM:

- lowering and raising the heating of the tubes by $\pm 7\%$ from normal;
- change in the nominal voltage supplied (this is especially effective

in checking the triggers for lack of symmetrization, by means of change of bias on one of the grids of the tubes by $\pm 4\%$.

test for vibration resistance of the units.

As was shown by experience in operation, the most effective preventive inspection proves to be change in the system of power supply for heating the tubes. This method will quickly reveal the tubes which have partially lost their emission and are to be substituted in order to prevent unreliable working of the MMD.

The non-standard units: amplifiers of recording and reading from the drum and tape, diodes for reading from the drum (Dv), multivibrators (M), path inverter unit (ID), valve unit (Vb)—all these are checked for dependability only by changing the heating voltage, and this has been justified in operation.

2. CHECKING THE MAGNETIC DRUM

The size of the gap between the magnetic coating and the heads affects to a great extent the working of the magnetic drum. Normally, starting with possible wobbling of the bearings of the drum, and the necessary amplitude of the signals to be read, the extent of the gap, as shown above, is fixed at 40 to 50 μ . With a change in temperature of the drum of $\pm 15^\circ$, the gap in accordance with various temperature coefficients of expansion of the drum and mounting, is sharply changed, and this brings about a change of the recorded and read signals within broad limits. It is therefore desirable to maintain the temperature of the drum constantly within the limits of $\pm 5^\circ$.

The condition of the coating on the drum, and all the channels of recording and reading, are checked by the following method. On all the paths of the group of the drum, there is recorded an arbitrary code and repeated reading of it is done with a check on the indications of the control computer*.

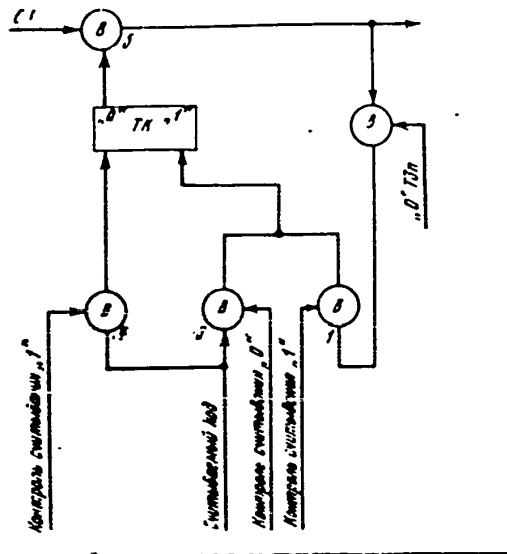


Fig. 45. Outline Circuit of the Check of Reading From the Magnetic Drum

If the indications of the computer on each reading are repeated and correspond to the indications in recording, this will be the sign of correct reliable operation of the group. If the indications of the control computer in recording and reading do not always coincide, this is a sign of imperfect operation.

*The control computer is an ordinary four-stage binary computer onto the input of which there passes the whole code to be recorded or read. After conversion by the modulus 16 on the computer one gets the remainder of the general number of pulses of the code. The magnitude of each remainder may be from 0 to 15 inclusive.

In order to detect the place of the defect in the circuit, one records the code "1" on every place of one group of the drum, and after this the checking reading is done. The outline circuit of the reading device is shown in Fig. 45.

In checking the reading of the code "1" by a high potential of +100v, from the control desk of the MMD, valves V_1 and V_4 are opened, which connect up the circuit with the control.

Valve V_2 is opened by a high potential "0" of the trigger RT (sign of reading).

From the moment of the beginning of the reading onto the input of the valve V_2 , there pass the SP, each one of which puts the control trigger (TC) in position "1" and thereby blocks the input circuit for the following SP, and the corresponding SP, the code pulse, delayed by $7.5 \mu \text{ sec}$, puts TC in position "0" and lifts the blocking from the valve V_5 .

If the "1" of the code is not taken into account, the control trigger remains in position "1", and blocks the passage of the next synchronizing pulse, and the computers show the number of the track, the number of the figure on it and the step in the figure from which the "1" of the code is not taken into account.

By this method, we quickly determine where the defect is in the channel of recording and reading. As a rule, the loss of the code occurs at once on the whole track. The cause may be that something is out of order with the diode of recording or reading or a break in the winding of the multiple wound transformer of the AR-MD. Mechanical damage to the coating may only occur in the case of overheating the drum, which causes a reduction air gap

between the magnetic coating and the heads. Such a phenomenon is considered damage and should not be permitted.

For checking the reading "0" on the whole surface of the group of the drum, one records code "0" using the same circuit (see Fig. 45). From the control board (CB MMD), there is given out a high potential onto valve V_3 , and onto valves V_1 and V_4 , a low one, a closing potential.

Valve V_3 which is on the unit input of the trigger of control (TC), is open all the time by a high potential. It is enough to erase one place badly on the drum for a parasitical pulse to read, and the trigger TC will be set through the valve V_3 in the position "1". As in the first case, the input circuit of the SP will be blocked, and the stopped computers will show the place from which the parasitical pulse is read.

To reveal the specific cause of the malfunction in the recording and reading channel, one sets up from the control desk of the MMD a system of continuous recording or reading from a given path of the drum and visual observation is made with the aid of an oscilloscope. The dependability of the recording of a code on the magnetic drum and the reading from it is checked by the measurement of the bias in the cascade of amplification (APMD).

The greater the amplitude of the pulses to be read, the greater the bias with which all the unit code pulses are normally read. On the other hand, the better the recording of the code "0" is done, the less the amplitude of the parasitical pulses passing to the input of the amplifier. A bias which is as low as possible is demanded so as not to permit parasitical pulses through the valve. By the measurement of the negative bias on the

AP-MD within the limits of which the code "1" and the code "0" are read, one checks the dependability of the work of the whole channel.

In the device described, the reading of "0" is done with the bias (displacement) near to zero volts (checking for the absence of parasitical reading).

When continuous units are recorded, the reading still proceeds normally with negative bias (about 45 v). If the MMD is working normally, for establishing the identical conditions during the reading of the codes "1" and "0" the bias is selected as an arithmetical mean: $0 + (-45) \approx -20$ v.

With basic units of the BESM known beforehand to be correct, and an internal memory device, the checking of the working of the MMD for dependability of recording and reading can easily be done in accordance with a special program consisting of a few commands.

3. CHECKING THE DEVICE WITH THE MAGNETIC TAPES

A preventive checking of the work of the magnetic memory device operating on tape (MMDT) is done with a lowering of the heating of the tubes.

Since, in working with the magnetic tape, one uses the same automatic circuits as when using the drum, it is necessary to check only the separate circuits of the device.

The checking and the control are done from the control desk of the MMD in the following way. On the tape, one records several different groups of codes. With the recording of each group, the indications of the control computer are fixed and the reading is done. If the indications of the control computer coincide with its indications on recording, the opera-

tion of the tape is considered correct.

For dependable working of the MMDT, of more significance is the quality of the magnetic tape. At the working frequency of 16 kcps and a rate of tape feed of 2 M/sec., the linear density of the recording amounts to 8 pulses on 1 mm of tape length.

If on the magnetic coating of the tape there are mechanical defects, even on small areas, then this will lead to unreliability of the work. The quality of the magnetic tape during the control is checked for the absence of parasitical reading. For this purpose, when the circuit is connected for erasing all the reading, circuits are opened, and the tape drive is switched on. The tape passes over the erasing head, and after this, onto the reading head. If the magnetic coating of the tape is damaged at some spots, parasitical pulses may be produced there, the existence of which is revealed by the position of the counters, which were set in advance in position "0". In such a checking, the control circuit reacting to the presence of pulses should be connected in.

To check the tape for the recording of "1", a large group of numbers are recorded with the code "1", and in reading them, the control circuit begins to work (Fig. 46). The synchronizing pulses are recorded on the track SP always in full (to each 39-step code, there correspond 40 synchro-

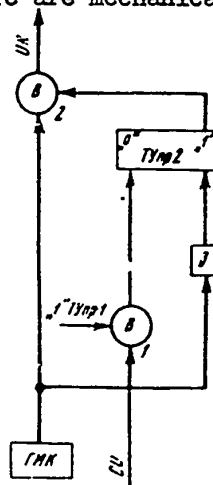


Fig. 46. Outline Circuit of Control of Reading from Magnetic Tape

nizing pulses). Therefore, the circuit given is used not only in preventive checking, but also for normal work of the MMDT in checking for the presence of the full number of synchronizing pulses.

The synchronizing pulses to be read passing with a frequency of 16 kcps through valve V_1 , set the control trigger (CoT2) in the "0" position. Onto the input of valve V_2 , there pass the pulses of frequency of about 2 kcps from the outside generator. These same pulses pass through delay 3 to the unit input of the control trigger No. 2 in a period of time which is a small fraction of the time between the pulses.

It is not hard to see that the circuit operates and gives out from the output of valve V_2 a control pulse in reading, only in the case when, in the interval between two neighboring control pulses, control pulses do not pass. In this way, the circuit reacts to the absence of a series of synchronizing pulses. With the given density of recording, a whole group of pulses is hardly ever recorded on the damaged tape.

Such a circuit operates stably in reading even from a patched-together tape. At the patched place of the tape, the recording is obtained imperfectly, and as experience has shown, it is not possible to use a patched tape for work.

The testing of magnetic tape for dependability can be accomplished by a special program when working from the basic device of the BESM.

As a result of the application of the preventive checking methods described, the MMD operates reliably. In carrying on preventive checking even for three or four days, not a single unreliable element of the circuit of the MMD turns up which would require replacement. In practice, there is

no need to replace any units of the MMD in the course of seven to ten days of work, since the whole device works reliably.

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Circuits and Specifications of Units of the MMD
Specifications of the Standard Unit T

Designations on Dwg. Fig. 47	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁ , L ₂	Tube	6Kh6S	—	1	ChTU 01.220.52
L ₃ , L ₄	"	6N8S	—	1	ChTU 01.310.52
L ₅ , L ₆	"	6Kh6S	—	1	ChTU 01.220.52
L ₇ , L ₈	"	6N8S	—	1	ChTU 01.310.52
R ₁	Resistor	VS-2	1.3 k-ohm \pm 5%	1	—
R ₂	"	VS-2	8.2 k-ohm \pm 10%	1	—
R ₃	"	VS-2	24 k-ohm \pm 5%	1	—
R ₄ , R ₅	Resistors	VS-2	20 k-ohm \pm 5%	2	—
R ₆ , R ₇	"	VS-2	20 k-ohm \pm 5%	2	—
R ₈	Resistor	VS-2	24 k-ohm \pm 5%	1	—
R ₉	"	VS-2	8.2 k-ohm \pm 10%	1	—
R ₁₀ , R ₁₁	Resistors	VS-0.5	100 k-ohm \pm 20%	2	—
R ₁₂ , R ₁₃	"	VS-0.5	10 k-ohm \pm 10%	2	—
R ₁₄	Resistor	VS-0.5	6.8 k-ohm \pm 5%	1	—
R ₁₅	"	VS-1	3.3 k-ohm \pm 5%	1	—
R ₁₆	"	VS-0.5	6.8 k-ohm \pm 5%	1	—
R ₁₇ , R ₁₈	Resistors	VS-0.5	10 k-ohm \pm 10%	2	—
C ₁ , C ₂	Capacitors	KSO-5	0.01 microfarad \pm 20%	2	—
C ₃ , C ₄	"	KTK-1	20 microfarad \pm 5%	2	—
C ₅	Capacitor	KSO-5	0.01 microfarad \pm 10%	1	—
C ₆	"	KTK-1	100 micromicrofarad \pm 10%	1	to 6800 micromicrofarad
C ₇ , C ₈	Capacitors	KSO-5	0.01 microfarad \pm 20%	2	—
C ₉	Capacitor	KTK-1	100 micromicrofarad \pm 10%	1	to 4700 micromicrofarad
C ₁₀ , C ₁₁ , C ₁₂	Capacitors	KSO-5	0.01 microfarad \pm 20%	3	—
C ₁₃	Capacitor	KBG-I	0.01 microfarad \pm 20%	1	—
C ₁₄	"	KTK-1	100 micromicrofarad \pm 20%	1	—
C ₁₅ , C ₁₆	Capacitors	KSO-5	from 0.01 microfarad	2	—
C ₁₇	Capacitor	KTK-1	100 micromicrofarad \pm 10%	1	to 4700 micromicrofarad
C ₁₈	"	KBG-I	0.05 microfarad \pm 20%	1	—
L ₁ , L ₂	Coil	—	1 mhy	2	—
L ₃ , L ₄	"	—	4 "	2	Dwg. No. 0303-00
N. L.	Neon Tube	MN-5	—	1	Dwg. No. 0304-00
	Tube Panel	Ceramic	8-pin	4	VN-647-52
	Plugs and sockets	—	20-contact	2	V-65869006

Translator's note: Latin letters, R, C, and L, were used in the original for resistor, capacitor, and induction coil; the other letters designating various parts have been transliterated from the Cyrillic.

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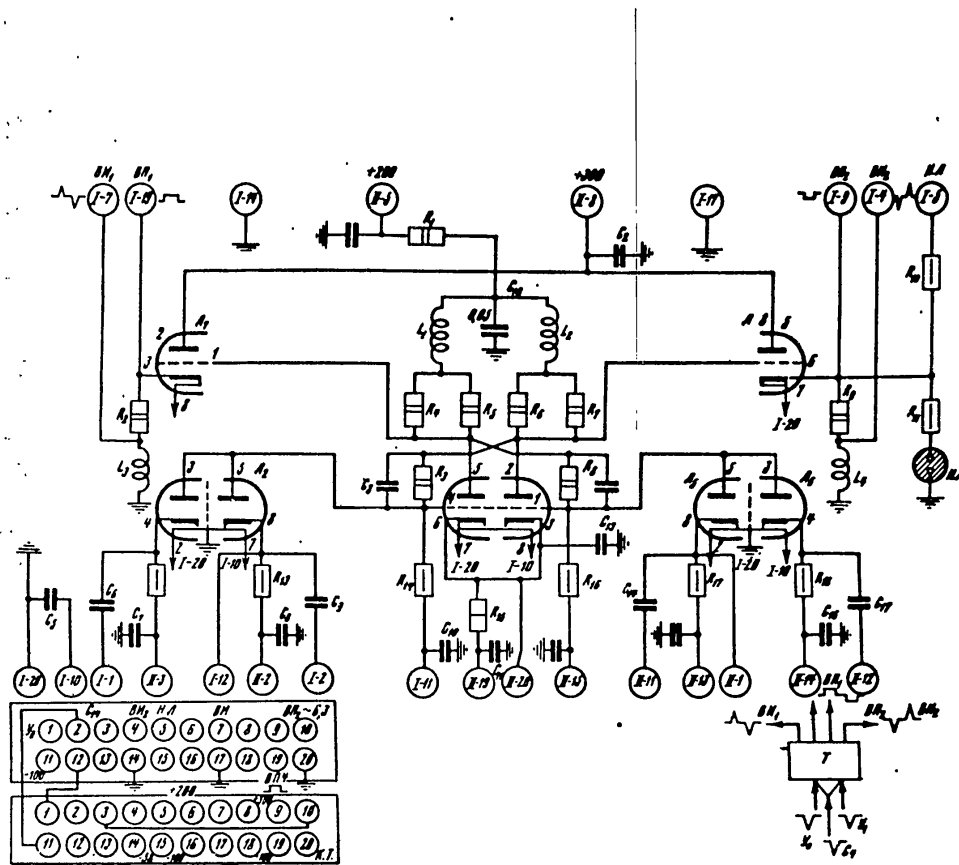


Fig. 47. Circuit of the Standard Unit, T

Specifications of the Standard Unit F (Φ)

Designations on Dwg. Fig. 48	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁ , L ₂	Tube	6Kh6S	—	1	ChTU 01.220.52
L ₃	"	6P9	—	1	ChTU 01.400.52
L ₄	"	6P3S	—	1	ChTU 01.110.52
L ₅	"	6P5S	—	1	ChTU 10.754.52
R ₁	Resistor(s)	VS-0.25	6.8 k-ohm ±20%	1	—
R ₂ , R ₃ , R ₄	"	VS-2	6.8 k-ohm ±10%	3	—
R ₅	"	VS-1	6.8 k-ohm ±20%	1	—
R ₆ , R ₇	"	VS-0.5	1.5 k-ohm ±10%	2	—
R ₈	"	VS-0.5	2.2 k-ohm ±10%	1	—
R ₉	"	VS-0.5	10 k-ohm ±10%	1	—
C ₁ , C ₂ , C ₃ , C ₄	Capacitor(s)	KSO-5	0.01 microfarad ±20%	4	—
C ₅	"	KTK-1	100 micromicrofarad ±10%	1	—
C ₆ , C ₇ , C ₈	"	KSO-5	0.01 microfarad ±20%	5	C ₉ and C ₁₀ to 4700 micro- microfarad
C ₉ , C ₁₀	"	KSO-5	0.01 microfarad ±20%	5	
C ₁₁ , C ₁₂	"	KSO-2	680 micromicrofarad ±10%	2	
T ₁	Pulse transformer	F (Φ)		1	Dwg. No. 0014-00
L ₁	Coil		1 mh ± 5%	1	Dwg. No. 0303-00
—	Tube panels	—	8-pin	4	VN-647-52
—	Plugs and sockets		20-contact	2	V-65869006

Specifications of the Standard Unit V

Designations on Dwg. Fig. 49	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁ , L ₂	Tubes	6Zh4	—	2	ChTU 01.401.52
R ₁	Resistor	VS-0.5	100 k-ohm ± 5%	1	—
R ₂ , R ₃	"	VS-0.5	4.7 k-ohm ± 5%	2	—
R ₄	"	VS-0.5	100 k-ohm ± 5%	1	—
C ₁ , C ₂ , C ₃	Capacitor	KSO-5	0.1 microfarad ±20%	3	—
C ₄	"	KTK-1	180 micromicrofarad ±10%	1	—
C ₅ , C ₆ , C ₇ , C ₈	"	KSO-5	0.01 microfarad ±20%	4	—
C ₉	"	KTK-1	180 micromicrofarad ±10%	1	—
C ₁₀	"	KSO-5	0.01 microfarad ±20%	1	—
T ₁ , T ₂	Pulse transformers	V	—	2	Dwg. No. 0015
—	Tube panel	Ceramic	8-pin	2	VN-647-52
—	Plugs and sockets	—	20-contact	1	V-65869006

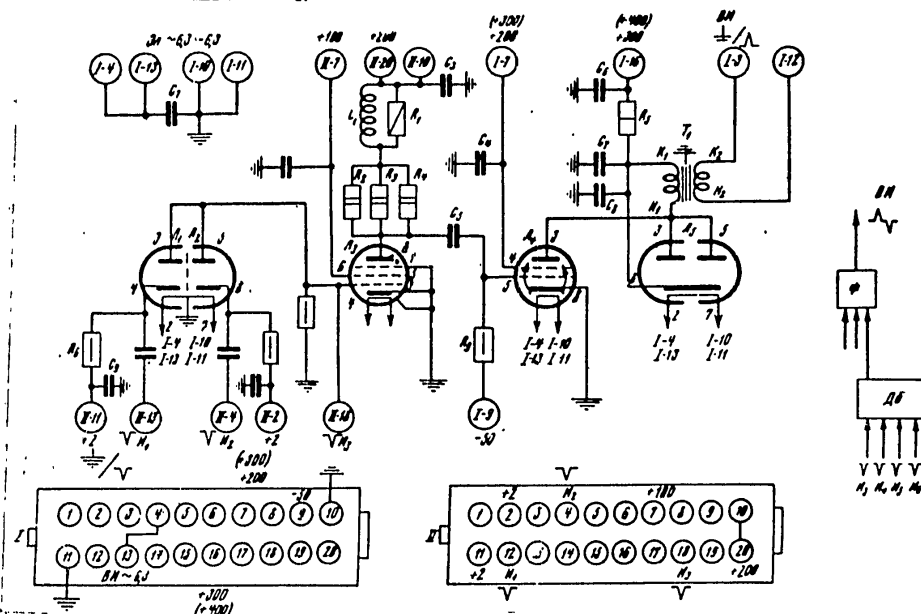
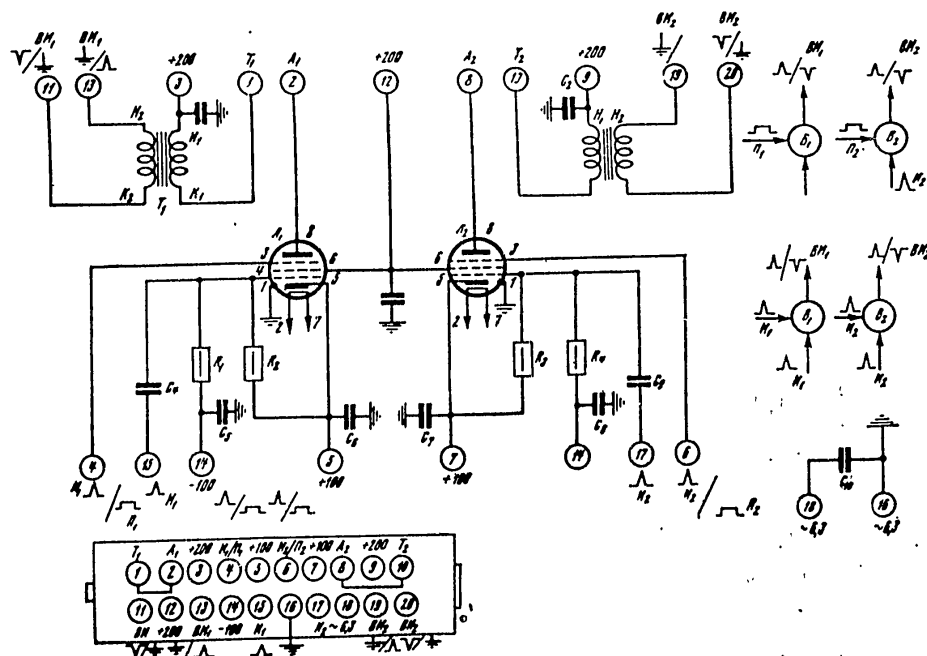


Fig. 48. Circuit of Standard Unit, F (S)



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Specifications of the Standard Unit Zv (Ae)

Designations on Dwg. Fig. 50	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁ , L ₂	Tube	6N8S	—	1	ChTU 01.310.52
R ₁	Resistor	VS-1	3.3 k-ohm $\pm 10\%$	1	—
R ₂	"	VS-0.5	100 k-ohm $\pm 5\%$	1	—
R ₃	"	VS-0.5	15 k-ohm $\pm 5\%$	1	—
R ₄	"	VS-0.5	2.2 k-ohm $\pm 10\%$	1	—
R ₅	"	VS-0.5	470 k-ohm $\pm 10\%$	1	—
C ₁ , C ₂	Capacitor(s)	KSO-1	0.01 microfarad $\pm 10\%$	2	—
C ₃	"	KTK-1	150 micromicrofarad $\pm 10\%$	1	—
C ₄ , C ₅ , C ₆	"	KSO-5	0.01 microfarad $\pm 20\%$	3	—
T ₁ , T ₂	Pulse trans- formers	V •	—	2	Dwg. No. 0015
L. Z.	Delay line	—	—	1	Dwg. No. 0300-00
—	Tube panel	Ceramic	8-pin	2	VN-647-52
—	Plugs and sockets	—	20-contact	1	V-65869006

Specifications of the Standard Unit Ia

Designations on Dwg. Fig. 51	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁ , L ₂	Tubes	6P9	—	2	ChTU 01.400.52
R ₁	Resistor(s)	VS-1	20 k-ohm $\pm 10\%$	1	—
R ₂ , R ₃ , R ₄ , R ₅	"	VS-2	15 k-ohm $\pm 10\%$	4	—
R ₆	"	VS-0.25	150 k-ohm $\pm 20\%$	1	—
R ₇ , R ₈ , R ₉ , R ₁₀	"	VS-2	15 k-ohm $\pm 10\%$	4	—
R ₁₁	"	VS-1	20 k-ohm $\pm 10\%$	1	—
R ₁₂	"	VS-0.25	150 k-ohm $\pm 20\%$	1	—
R ₁₃ , R ₁₄ , R ₁₅	"	VS-0.5	1.5 k-ohm $\pm 5\%$	3	—
R ₁₆	"	VS-0.5	1.6 k-ohm $\pm 5\%$	1	Specially selected
R ₁₇	"	VS-0.5	1.8 k-ohm $\pm 5\%$	1	—
R ₁₈	"	VS-0.5	1.6 k-ohm $\pm 5\%$	1	—
R ₁₉	"	VS-0.5	1.8 k-ohm $\pm 5\%$	1	Specially selected
R ₂₀ , R ₂₁ , R ₂₂	"	VS-0.5	1.5 k-ohm $\pm 5\%$	3	—
C ₁ , C ₂	Capacitor(s)	KSO-5	0.01 microfarad $\pm 20\%$	2	—
C ₃ , C ₄ , C ₅	"	KSO-5	0.01 microfarad $\pm 20\%$	3	—
C ₆ , C ₇	"	KTK-1	51 micromicrofarad $\pm 5\%$	2	—
C ₈	"	KSO-5	0.01 microfarad $\pm 20\%$	1	—
L ₁	Inductance	—	1 μ h $\pm 10\%$	1	Wound on resistors
L ₂	"	—	1 μ h $\pm 10\%$	1	R ₆ and R ₁₂
—	Tube panel	Ceramic	8-pin	2	VN-647-52
—	Plugs and sockets	—	20-contact	1	V-65869006

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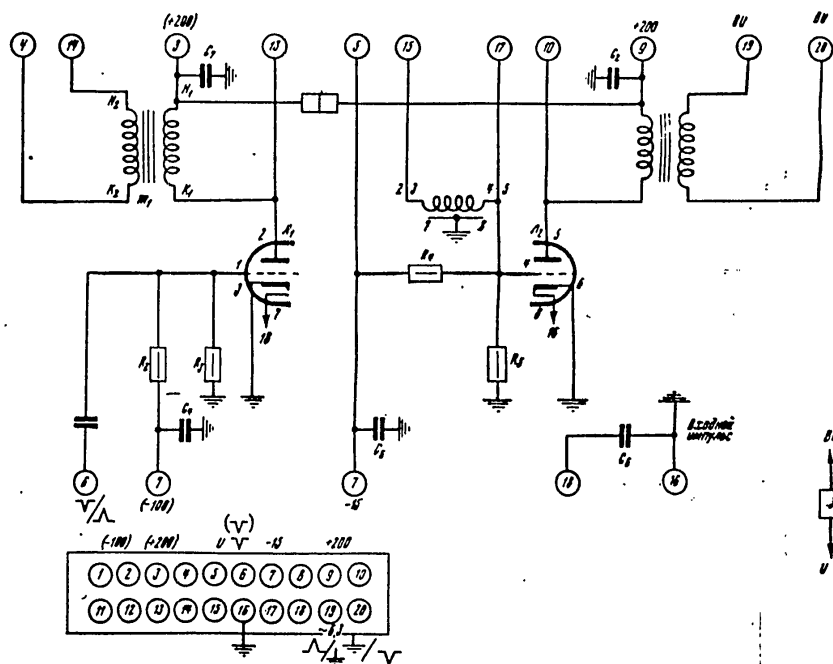


Fig. 50. Circuit of the Standard Unit Zv (Ae)

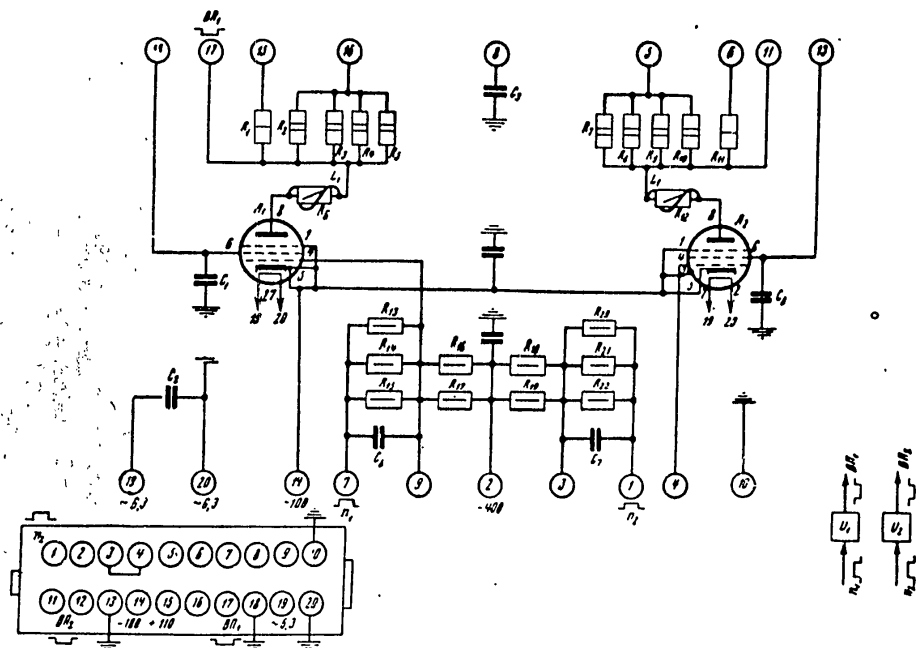


Fig. 51. Circuit of the Standard Unit Ia

Specifications of the Standard Unit Ka

Designations on Dwg. Fig. 52	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁ , L ₂	Tubes	6P3S	—	2	ChTU 01.110.52
R ₁	Resistor(s)	VS-05	100 k-ohm $\pm 20\%$	1	—
R ₂	"	VS-05	220 ohm $\pm 20\%$	1	—
R ₃	"	VS-0.5	1.5 megohm $\pm 20\%$	1	—
R ₄ , R ₅	"	PE-11	2.5 k-ohm $\pm 5\%$	2	—
R ₆	"	VS-05	1.5 megohm $\pm 20\%$	1	—
R ₇	"	VS-05	220 ohm $\pm 20\%$	1	—
R ₈	"	VS-05	100 k-ohm $\pm 20\%$	1	—
C ₁ , C ₂ , C ₃	Capacitors	KSO-5	0.01 microfarad $\pm 20\%$	3	—
C ₄ , C ₅	"	KTK-1	180 micromicrofarad $\pm 20\%$	2	—
C ₆ , C ₇	"	KSO-5	0.01 microfarad $\pm 20\%$	2	—
—	Tube panel	Ceramic	8-pin	2	VN-647-52
—	Plugs and sockets	—	20-contact	1	V-65869006

Specifications of the Standard Unit Kb

Designations on Dwg. Fig. 53	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁ , L ₂	Tubes	6N8S	—	1	ChTU 01.310.52
L ₃ , L ₄	"	6N8S	—	1	ChTU 01.310.52
R ₁ , R ₂ , R ₃	Resistor(s)	VS-2	10 k-ohm $\pm 10\%$	4	—
R ₄	"	"	"	"	"
R ₅	"	VS-0.25	10 k-ohm $\pm 20\%$	1	—
R ₆ , R ₇	"	VS-05	3.3 megohm $\pm 20\%$	2	—
R ₈ , R ₉	"	VS-0.25	10 k-ohm $\pm 20\%$	2	—
R ₁₀ , R ₁₁	"	VS-0.5	3.3 megohm $\pm 20\%$	2	—
R ₁₂	"	VS-0.25	10 k-ohm $\pm 20\%$	1	—
C ₁ , C ₂ , C ₃	Capacitors	KSO-5	0.01 microfarad $\pm 20\%$	3	—
C ₄ , C ₅ , C ₆	"	KSO-5	0.01 microfarad $\pm 20\%$	3	—
L ₁ , L ₂ , L ₃	Coils	Type 1	4 mh $\pm 5\%$	4	Universal
—	Tube panel	Ceramic	8-pin	2	VN-647-52
—	Plugs and sockets	—	20-contact	1	V-65869006

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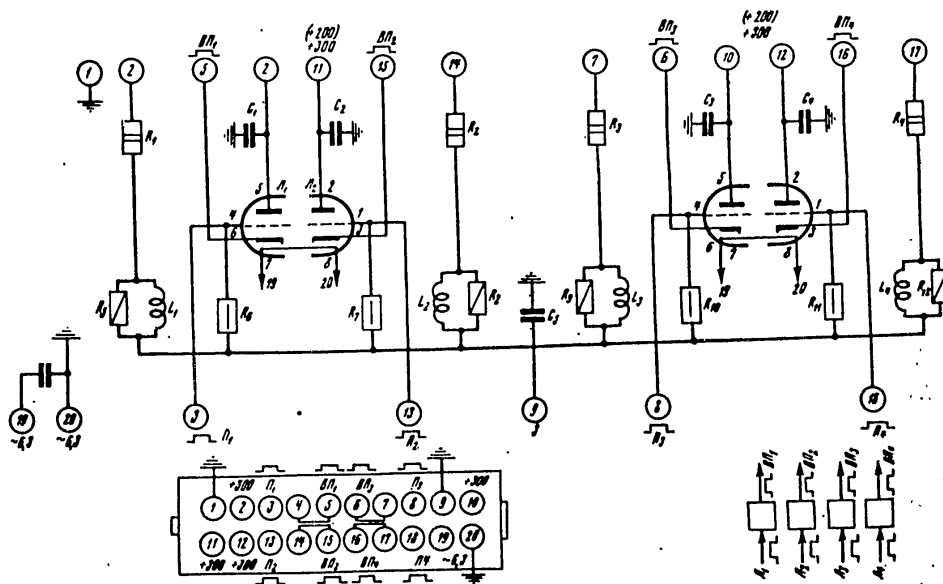


Fig. 53. Circuit of the Standard Unit, Kb (Cb)

Specifications of the Standard Unit Da

Designations on Dwg. Fig. 54	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁ , L ₂	Tubes	6Kh6S	—	1	ChTU 01.220.52
L ₃ , L ₄	"	6Kh6S	—	1	ChTU 01.220.52
R ₁	Resistor	VS-0.25	10 k-ohm ±20%	1	—
R ₂	"	VS-2	10 k-ohm ±10%	1	—
R ₃	"	VS-0.25	10 k-ohm ±20%	1	—
R ₄	"	VS-2	10 k-ohm ±10%	1	—
R ₅	"	VS-0.5	470 k-ohm ±20%	1	—
R ₆	"	VS-0.25	10 k-ohm ±20%	1	—
R ₇	"	VS-2	10 k-ohm ±10%	1	—
R ₈	"	VS-0.25	10 k-ohm ±20%	1	—
R ₉	"	VS-2	10 k-ohm ±10%	1	—
R ₁₀	"	VS-0.5	470 k-ohm ±20%	1	—
C ₁ , C ₂ , C ₃	Capacitors	KSO-5	0.01 microfarad ±20%	3	—
L ₁ , L ₂ , L ₃	Coils	Type 1	4 mh ±5%	4	Universal
L ₄	Tube panel	Ceramic	8-pin	2	VN-647-52
—	Plugs and sockets	—	20-contact	1	V-65869006

Specifications of the Standard Unit VZa

Designations on Dwg. Fig. 55	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁	Tube	6Zh4	—	1	ChTU 01.401.52
L ₂ , L ₃	"	6N8S	—	1	ChTU 01.310.52
R ₁	Resistor	VS-2	8.2 k-ohm ±10%	1	—
R ₂	"	VS-0.5	100 k-ohm ± 5%	1	—
R ₃	"	VS-0.5	4.7 k-ohm ± 5%	1	—
R ₄	"	VS-0.5	10 k-ohm ±10%	1	—
R ₅	"	VS-0.5	2.2 k-ohm ±10%	1	—
C ₁ , C ₂	Capacitor(s)	KSO-5	0.01 microfarad ±20%	2	—
C ₃	"	KTK-1	180 micromicrofarad ±10%	1	—
C ₄	"	KSO-5	0.01 microfarad ±20%	1	—
C ₅	"	KTK-1	180 micromicrofarad ±10%	1	—
C ₆ , C ₇ , C ₈	"	KSO-5	0.01 microfarad ±20%	1	—
C ₉	"	KTK-1	100 micromicrofarad ±10%	1	—
C ₁₀	"	KSO-5	0.01 microfarad ±20%	1	—
T ₁ , T ₂	Pulse trans- formers	V	—	2	Dwg. No. 0015
L. Z.	Delay lines	1	0.3 μsec	1	Dwg. No. 0299-00
—	Tube panel	Ceramic	8-pin	2	VN-647-52
—	Plugs and sockets	—	20-contact	1	V-65869006

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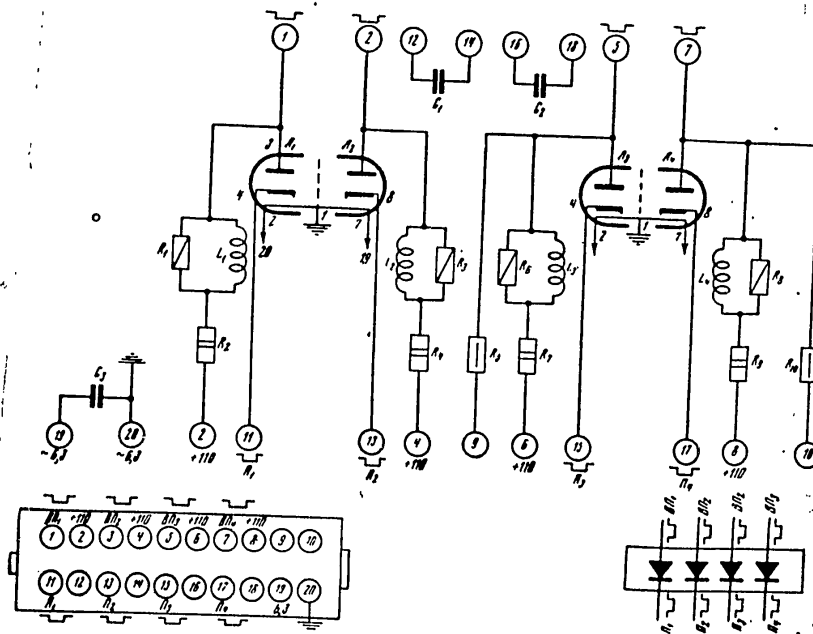


Fig. 54. . Circuit of the Standard Unit Da (Dp)

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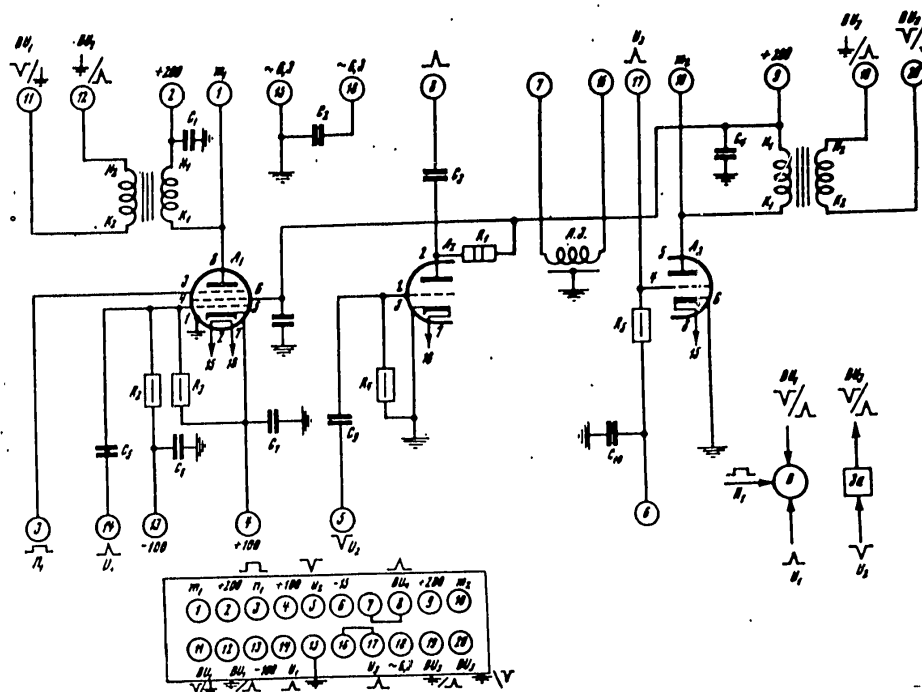


Fig. 55. Circuit of the Standard Units VZa (VAD) and VZb

Specifications of the Standard Unit VZb (IMD)

Designations on Dwg. Fig. 55 ¹	Nomenclature of Element	Mark or Material	Parameters	No. of Items	Notes
L ₁	Tube	6Zh4	—	1	ChTU 01.401.52
L ₂ , L ₃	"	6N8S	—	1	ChTU 01.310.52
R ₁	Resistor	VS-2	8.2 k-ohm $\pm 10\%$	1	—
R ₂	"	VS-0.5	100 k-ohm $\pm 5\%$	1	—
R ₃	"	VS-0.5	4.7 k-ohm $\pm 5\%$	1	—
R ₄	"	VS-0.5	10 k-ohm $\pm 10\%$	1	—
R ₅	"	VS-0.5	2.2 k-ohm $\pm 10\%$	1	—
C ₁ , C ₂	Capacitor(s)	KSO-5	0.01 microfarad $\pm 20\%$	2	—
C ₃	"	KTK-1	180 micromicrofarad $\pm 10\%$	1	—
C ₄	"	KSO-5	0.01 microfarad $\pm 20\%$	1	—
C ₅	"	KTK-1	180 micromicrofarad $\pm 10\%$	1	—
C ₆ , C ₇ , C ₈	"	KSC-5	0.01 microfarad $\pm 20\%$	3	—
C ₉	"	KTK-1	100 micromicrofarad $\pm 10\%$	1	—
C ₁₀	"	KSC-5	0.01 microfarad $\pm 20\%$	3	—
T ₁ , T ₂	Pulse trans- formers	V	—	2	Dwg. No. 0015
L. Z. ₁ , L. Z. ₂	Delay lines	1	0.3 μ sec	2	Dwg. No. 0299-00
—	Tube panels	Ceramic	8-pin	2	VN-647-52
—	Plugs and sockets	—	20-contact	1	V-65869006

¹In the circuit of VZb the delay line is designed for 0.8 μ sec